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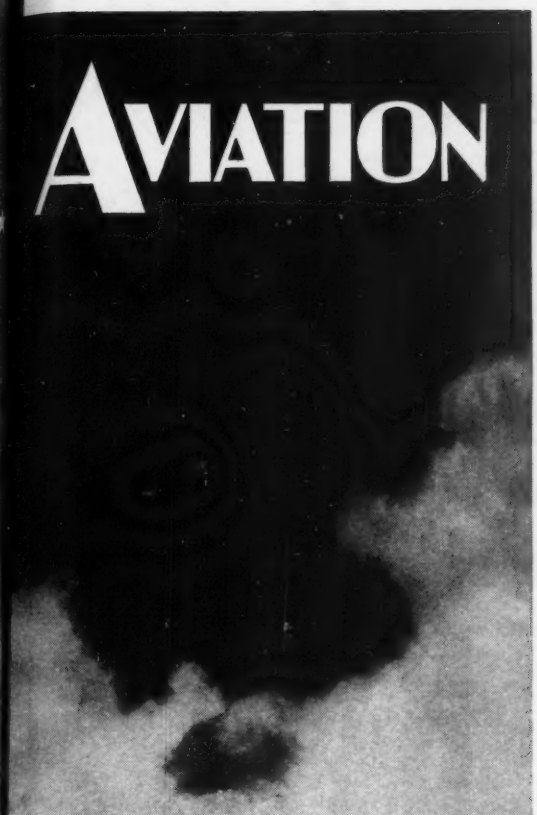

July, 1943

Volume 42 • Regular Edition • Number 7

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McGRAW-HILL PUBLISHING CO., INC. Publication office 99-129 North Broadway, Albany, N. Y. **Return postage guaranteed. Editorial and executive offices, 330 West 42nd Street, New York, N. Y.** Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; National Press Bldg., Washington; 6 South Broad St., Philadelphia; Hanna Bldg., Cleveland; 2-144 General Motors Bldg., Detroit; Paul Brown Bldg., St. Louis; 1427 Statler Bldg., Boston; Rhodes-Haverty Bldg., Atlanta; 601 W. 5th St., Los Angeles. JAMES H. McGRAW, Founder and Honorary Chairman; JAMES H. McGRAW, Jr., President; HOWARD EHRLICH, Executive Vice-President; MASON BRITTON, Vice-President; B. R. PUTNAM, Treasurer; JOSEPH A. GERARDI, Secretary; J. E. BLACKBURN, Jr., Director of Circulation. Aviation, 330 W. 42nd Street, New York. Published monthly, price 50c a copy, 50c in Canada. Allow at least ten days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York. Subscription rates—United States, Mexico and Central American Countries $3.00 a year, $4.00 for two years, $5.00 for three years. Canada, $3.50 for one year, $5.00 for two years, $6.00 for three years, payable in Canadian currency at par. Great Britain and British Possessions 30 shillings per year, 50 shillings for three years. All other countries $5.00 a year, $10.00 for three years. Entered as second-class matter September 3, 1936, at the Post Office, Albany, New York, under the Act of March 3, 1879. Volume 42, Number 7. Printed in U. S. A. Cable address: "McGrawhill New York." Member A.B.C. Copyright 1943 by McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y. The contents of this issue are copyrighted and may not be reproduced without the permission of the copyright owner. The following publications are combined with AVIATION: AERONAUTICAL ENGINEERING AIRCRAFT JOURNAL, and THE AVIATION NEWS. All rights to above names are reserved by the McGraw-Hill Publishing Co. Aviation is indexed in Guide to Periodical Literature and in Industrial Arts index.

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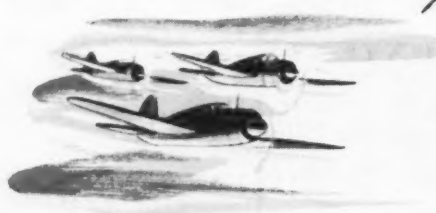

Needed...

a Dependable Guide for Flying Armor...

Sketched in the Pioneer Compass Laboratory by Norman Kenyon

...Pioneer ingenuity provides the solution

Adverse influences on the magnetic compass in a modern fighter are the heavy armor plate, guns, and maze of electrical wiring... all concentrated in and around the cockpit. Hence the need for a remote indicating compass with its sensitive element located away from such magnetic disturbances.

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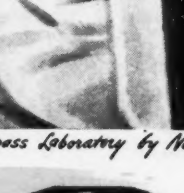

The "MAGNESYN" Remote Indicating Compass is typical of the advanced engineering of "PIONEER" Aircraft Instruments. It is an important member of "The Invisible Crew" of precision equipment which 25 Bendix plants from coast to coast are speeding to our fighting crews on world battle fronts.

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PIONEER INSTRUMENT DIVISION

Briefing for July

EMPHASIS IN THIS, AVIATION'S annual production issue, is on the manufacture of America's most potent offensive weapon—the heavy bomber. On all fronts, the Allies are surging forward in the greatest military effort the world has ever known. The scope and power of the Axis drives in the earlier phases of this war are utterly dwarfed in comparison with present Allied force. This is epitomized by strength in the air, and particularly bomber strength. The maximum effort of the Germans compares with something just over the minimum present effort of the Allies in their bombing offensives. But such a comparison is only in numbers of aircraft involved for the Germans never had anything to compare with the American *Flying Fortresses* and *Liberators*, or the British *Lancasters*. These mighty weapons are crushing Axis resistance and paving the way for total victory.

If credit can be apportioned, the fullest measure for development of the heavy bomber is due the United States. Originally dubbed as "flying targets," the American heavy bombers are proving to be "flying sledgehammers" and with their British counterparts will probably decide the war.

It is one thing to have developed these craft, but the really decisive factor is quantity production of them. In this respect, America is definitely "at home", and as a result the Axis is facing the mightiest array of military force man can accumulate, both quantitatively and qualitatively. This issue tells how it is being done.

An over-all picture of Allied productive strength is given in the editor's **Letter to Berlin** on page **110**. Adolf won't be very happy about this letter, but it may help to clarify the whole business for him. The din is pretty terrific in Germany right now and he may not have been able to hear Roosevelt and Churchill. What they had to say in terms of production is set forth and interpreted here for Adolf to read in his shelter and, frankly, we hope he dies from the exertion of burrowing a little deeper into the ground.

If the Nazis had their way, the terms *Flying Fortresses* and *Liberators* would be struck from human speech, because they are not pleasant words for them. The fact that these mighty craft are being built in quantity by a number of quantity specialists, will help underline the meaning of **Letter to Berlin.**

A glance at the contents page will reveal articles in this issue such as **Fortresses by Boeing**, page **124**; **Fortresses by Douglas**, page **130**; and **Fortresses by Vega**, page **136**; **Liberators by Consolidated Vultee**, page **146**; and **Liberators by Ford**, page **152**. The editors of AVIATION have ranged far and wide to round up this collection of production articles which tell in detail how these five great aircraft manufacturers produce the Boeing and Consolidated Vultee designed four-engine bombers.

Fighters and attack bombers are also vital components of our air power, and these are presented here in the articles, **Mustangs by North American**, on page **162**; and **Avengers by Eastern**, on page **168**. North American established a world's record in developing a first-line fighter craft in an unbelievably short time, and their production rate is equally spectacular. Eastern Aircraft Division of General Motors is very busy turning out the famous Grumman *Avenger* torpedo bomber, which represents a big package of bad news for the Japs.

ROUNDING OUT the production of this issue is a story of how Buick machines Pratt & Whitney cylinder heads, on page **177**, and description of a new process pioneered and employed at Fleetwings, which simplifies template reproduction, page **178**.

AVIATION'S LONDON CORRESPONDENT brings his observations of American aircraft in action in Europe up to date on page **116**, in his article **Those Claims are Right**. The European point of view is generally very illuminating, and AVIATION'S readers will probably note in Mr. Cave's remarks a growing appreciation of American equipment in that theater.

TWO SCHOOLS of thought on the postwar aspects of aviation finance are analyzed in the article, **Slump . . . or Surge**, on page **113**. While it is obvious that the going will have its ramifications, there is no need for pessimism with respect to the future. AVIATION'S financial editor takes a **Midyear Checkup on Aviation Finance** on page **114**. He analyzes the 1942 stockholders' reports in this article and takes a new bearing on the prospects for the balance of the year.

IN THE EARLIER DAYS of the present war, the number of Allied aircraft, ships, and tanks destroyed by our own fliers due to mistaken identification sometimes reached appalling totals. The Renshaw system of identification training teaches fliers and ground observers to recognize friendly and enemy equipment instantaneously, and results have been excellent. The history of this development and the training methods used are described in **Split Second Recognition, a New Allied Weapon**, on page **119**.

IN THE AIR TRANSPORT SECTION, there begins an important series of articles on **Cruise Control** by Messrs. Speas, Farah, and Hinton of American Airlines. In this first article on page **201** they discuss power requirements and their uses in airlines operations.

OUR ORIGINAL RUBBER BAND BOY, Assistant Editor David Baker, went on a long stretch to find out about the famed repair base at Edmonton, and reports on its operations in **International Overhaul** in the Maintenance Section on page **208**. He then pushed on to Seattle to see how Boeing builds *Flying Fortresses*. The magnetic north pole then took a grip on his dollar watch and he found himself in Whitehorse on the Alaska Highway. Result: another piece in the Military Section about the unsung but spectacularly vital operations of the Ferry and Air Transport Commands in the far north. See **Northwest Deliveries** on page **224**.

Incidentally, Associate Editor John Foster, Jr. was lured by the tropics and took umpteen shots in the arm for an assignment to fly the "banana run" through Central America with the Air Transport Command. He will report on their operations next month.

Unable and unwilling to resist the get-out-and-see disease, Managing Editor Gene Miller did a nine-day trick with the Army Air Forces at the School of Applied Tactics in Florida. With plenty of tactical flying under his belt and considerable additional research, he is busy batting out a series on tactics which will soon be ready for publication.

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Engineering Design
—Creator of America's Mechanized Might

In war, as well as in peace, the design engineer is the vital link between the inventive mind and the mass-production reality

IT IS gratifying and interesting to note that reports of new "secret weapons" not only have reversed their course during the past few months . . . they also have increased in frequency. Once they filled us with dread and misgiving. Today the enemy does the worrying.

Word about the latest new Army weapon reached us as this was being written . . . a 2½ ton truck that performs on water as well as on land with equal efficiency. "The Duck", resembling an overgrown amphibious jeep, is particularly suited to landing operations where docks are lacking. Loaded with 20 fully equipped soldiers or their equivalent in supplies, its propeller runs it ashore. It climbs the beach on its six-wheel drive and continues the trip on land.

This important addition to our "second-front" fighting equipment, coming so closely on the heels of the now famous tank-killing "Bazooka", is one of many history making contributions of American design engineers — the men who transform nebulous ideas into practical realities — the men who make our war machines superior to those of our enemies.

Invasion and eventual victory became a certainty as soon as America's design engineers threw their full effort into the war against aggression. Adapting intricate ordnance designs to mass production, these men developed weapons such as the M-10 destroyer of Rommel's tanks and brought out the new fighting planes and bombers that have won the air superiority that has turned the tide against the Axis. Taking ideas and giving them form, selecting the materials of construction, deciding upon the method of fabrication, adapting the electrical and mechanical parts that power the product, specifying the finish that protects and beautifies it . . . these men are the focal point of American production. Their ingenuity has no parallel. Once they put automobiles on a mass production basis and within the reach of all. Today, after less than three years and with little previous experience in armament design, they have brought America's war weapons to the highest efficiency . . . surpassing Hitler's weapons despite all the vaunted scientific wizardry of the Germans and their ten year start.

At this point it is well to remember that while Germany's military might is traceable to its superiority in armament, many of the basic technological discoveries (including the airplane and the submarine) are the products of American genius. The Germans always have been aware of the military advantages of technological superiority and have forced its expansion with all their might. They knew that mobility and surprise play a decisive role in modern warfare and their design engineers were kept busy, with unique intensity, to achieve unprecedented results in fast-moving, hard-hitting fighting equipment. Our own military and industrial engineers did not go into action until it became certain that we would be involved in the conflict. But even before our country actually embarked on its Preparedness Program they were busily engaged in developing the designs of our war equipment. Tanks, planes, guns, ships and hundreds of other apparatus and machines of war were studied. Carefully selected committees of our national engineering societies were organized under the leadership of the Army Ordnance Department to serve as advisors and consultants in the development of advanced designs of tanks and other motorized equipment of war. The above mentioned "Duck" and the now famous Sherman tank are just two of the many results of these efforts.

After the Preparedness Program had officially been launched and Congress had made its initial appropriation, it was necessary to create the manufacturing blueprints from which the engines of war could be built. Because the designs of the machines of production, as well as the designs of the products themselves, determine the speed and economy with which anything can be manufactured,

This is the thirteenth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

the capacity of our industrial system is dependent, to a considerable extent, upon the ability and ingenuity of American design engineers. Germany's military might was successfully mechanized because Germany, for more than 10 years preceding the war, was riding the wave of a world-wide technological revolution. This revolution was as far-reaching as the advent of the electric motor and the internal combustion engine. It was born of the profusion of inventions and discoveries since the last war. German design engineers took advantage of every one of these.

If we are to defeat our enemies and if we are to continue to play the leading role in the post-war world we must make better use of the new technology than do our enemies. The job is up to American product engineers who already have made tremendous strides in designing the intricate machinery of production and of war equipment. Much remains to be done however.

It has been said that the Germans have not developed one single item that can be classified as basically original, nor are there indications that any so-called "secret weapon" will henceforth be developed by them. Today the Nazis are completely outclassed by the tremendous manpower of engineering brains that is at the disposal of American industry. Although we were faced by the same fundamental problems of shortages in materials, manpower and time, our engineers not only solved these problems quickly and effectively, but they outstripped the enemy by the preponderant weight of talent which we were able to bring to bear upon our problems. As is evidenced by studies of the designs of captured German war equipment, our airplanes are faster, carry heavier loads, have superior protective armor and heavier armament. Our tanks, especially the Shermans, stand unmatched. Our tractor-mounted artillery excels theirs in fighting power. Our automotive vehicles are the envy of the world. Our battleships are supreme. Our signal and detection devices are frustrating all of our enemies' attempts to dominate the seas.

And as we approach the end of the conflict, the pattern of which already has been set, the forces that converted American industry from peace to war-production will again be brought into play, and the product engineer will continue to be the fulcrum. Our post-war industry will grow from his blueprint. Nor will his job be any less urgent, any less responsible, any less sweeping in its effects than were his efforts during the war-preparedness program.

Since the cessation of the manufacture of peace-time goods, many new materials and production techniques have been developed. Plastics, synthetic rubber and magnesium in the field of materials were relatively new and restricted in their uses when war came. So were powder metallurgy, induction heating, electrostatic heating, adhesives for joining metals and compressed resin-impregnated wood. The new possibilities in product design created by the electronic devices and applications developed during the war period virtually stun the imagination and the "atomic revolution" promises to change the entire pattern of manufacturing operations.

Never before has there been so much speculation about the future as there is today. Looking forward, who can doubt our limitless capacity to continue our industrial world leadership?

While no one can predict developments in product design in the post-war period, certain it is that they will be so vastly different and so far superior to existing designs that they will obsolete most products as we know them today. With engines of vastly superior metals, designed to burn 100 octane gasoline and built to a precision ten times greater than that of pre-war engines, our post-war automobiles will give from 40 to 60 miles to the gallon. Tires will last from forty to fifty thousand miles. The comfort and smoothness with which these cars of tomorrow will glide along are undreamed of today. Polaroid windshields will eliminate the glare of oncoming headlights and the driver will need to give but scant attention to the manipulation of his simplified gear shifts.

According to no less an authority than Igor Sikorsky, we stand on the threshold of a new air age in which the helicopter will contribute to the greatest prosperity we have ever known.

Prophecies are hard to make at a time like this but speedy house building seems to be a certainty in the world of tomorrow. Air conditioning, new methods of heating, humidifying and drying, promise to be necessities in the post-war home. Vacuum sweepers will be much lighter, less noisy and easier to manipulate. Washing-machines will be fully automatic and practically free of noise and vibration. Not only will our homes and most of the furnishings be of radically new design, but so will the factories and machines that produce them.

Only one factor can prevent the fulfillment of the dream of the product designer. His job is not accomplished over night. To convert sound ideas into production blueprints involves a great deal of time and money. The building of test models is an expensive and tedious procedure. An abundance of seed money is required to perfect the product, to develop mass-production methods and to bring it to fruition as a finished saleable product.

It is the patriotic duty of every industrial leader to hasten these developments so that the material benefits created by them may speed our progress along the road of abundance.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

Parable of a Prosperous Plane Maker

ONCE UPON A TIME there was a veteran aviation manufacturer who looked behind him—to notice for the first time in his life that the sheriff was not chasing him. While he was becoming accustomed to this strange feeling of freedom from debt, he glanced down at the little metal plate on his desk that read "Property of the Defense Plant Corporation". Suddenly he realized that he should go out and buy, while he could, a few of the things he had always wanted for his business. And so he called in his vice-presidential henchman and asked him to make a list of some of the things they ought to purchase.

The list came back within the hour, and the president began to check the items carefully. Most of them looked good. The wind tunnel was a natural. The materials laboratory was certainly important. But what was this curious matter down at the bottom of the page? . . . Two strange words without an explanation—"Marketing Research".

He knew the mental strain on the vice-president had been very great, but this was the first sign he had seen of a crack-up. He must insist that his henchman take that long-needed vacation.

No one was more surprised than the vice-president when the chief told him to take a rest. Finally he screwed up courage enough to ask him why. And reluctantly the president told him:

"Look at this list you gave me. Everything is well thought out, except this last item. What is this 'marketing research' business? Surely you are not serious about it."

The vice-president was on the spot. Finally he confessed that it was something that "the fool sales manager" had put him up to.

The chief thought fast. He said: "Let's buy it, and you may postpone your vacation".

PERHAPS this little parable is far fetched, but it needs to be. Scarcely a day passes without fresh evidence of the lack of merchandising sense in the aviation industry. This is no criticism of a business based originally on the once modest needs of government and the greater needs of the governments of foreign nations engaged in a long term armament race. For this kind of business the market was simply and clearly defined. But the end of this phase of aviation merchandising is now definitely in sight. Consider the trend of the aircraft production curve on page 110.

As recently as yesterday a manufacturer asked us if it was unpatriotic to look beyond the war. That curve is the answer.

There are two basic ingredients in the future prospects of an aviation manufacturer and both are absolutely essential. They are the market and the product. First, the manufacturer must find out who is likely to buy his products in the future and also just what kind of products the prospects will want. Second, he must organize the research and development necessary to supply the prospective buyer's needs.

IT MAY SOUND heretical to an industry conceived in technology to suggest that the customers' needs come first. But many a worthwhile airplane project has gone wrong because the manufacturer insisted upon developing it first, then trying to cram it down somebody's throat. The most successful products have been those designed in close cooperation with the people who were to use them. The uncomfortable truth is that the customer must be served as he wants to be served, and if *you* don't serve him somebody else will.

There is nothing more important at this time—and it is already a little late—than to gather every scrap of information obtainable on whom your buyers will be and what they are likely to want. Then, and only then, can you give an intelligent directive to the research and engineering departments on what to design.

Neither is it too early to think about building a merchandising organization at this time. Sales executives should now be contacting available talent for their organizations and should now be selecting distributors and dealers for their postwar products.

Market research is no simple matter to be tossed at the office boy. It requires imagination and a breadth of knowledge not frequently found. It requires expensive personnel, and often its approaches may be indirect if not completely negative. It may even prove to you that you are in the wrong kind of business, and that is hard to take by those who may have fancied themselves the builders of tools for supermen.

True, some aviation manufacturers are already doing a good job of it. None, however, is yet doing a good *enough* job. But those who do the best job soon enough are the ones who will be in business five or ten years from now.

Leslie E. Neville

EDITOR

Gen. "Hap" Arnold, AAF commanding general, pins wings on Cadet Thomas K. Oliver, West Point honor man. Army's high recognition of military aviation was affirmed in this first officiation by AAF officer at U. S. Military Academy's graduation exercises.

AVIATION'S
WAR COMMUNIQUE
NO. 19

America at War

As warplane production "revs up" to new highs, the military calculates that Axis could be beaten with existing types of craft . . . Aero avalanche is foreseen for Hirohito after Hitler takes count . . . Cut-backs raise questions . . . New considerations of postwar plane conversions, manufacture, and international transport.

AMERICAN AIRCRAFT PRODUCTION now is really rolling along, as nearly in balance with reference to its supply of materials, components, and parts as it will ever be. Allied air commanders know that the enemy can be beaten with existing types of planes and with existing production schedules. Our rate of production will be leveled off at about 10,000 craft per month around the first of the year. We could build more planes than that if we wanted to switch additional manpower, materials, and plant to aviation. But we probably won't.

Experimental departments in the industry and in the Services meanwhile are going right ahead with development of new types, though they know we can win without them. Time and materials spent on new super bombers—at least three are on the way—will be well invested, even if they never hit the Axis; these developments will all accrue to the improvement of transport safety and efficiency.

Recent aircraft production conferences in Washington (at which some tempers snapped) were mainly concerned with the urgent need for more planes *right now*. Though our contribution to the long range air war is assured and well organized, our battlefronts still lack enough planes, especially heavy bombers, to deliver the blows our military believe ought to be

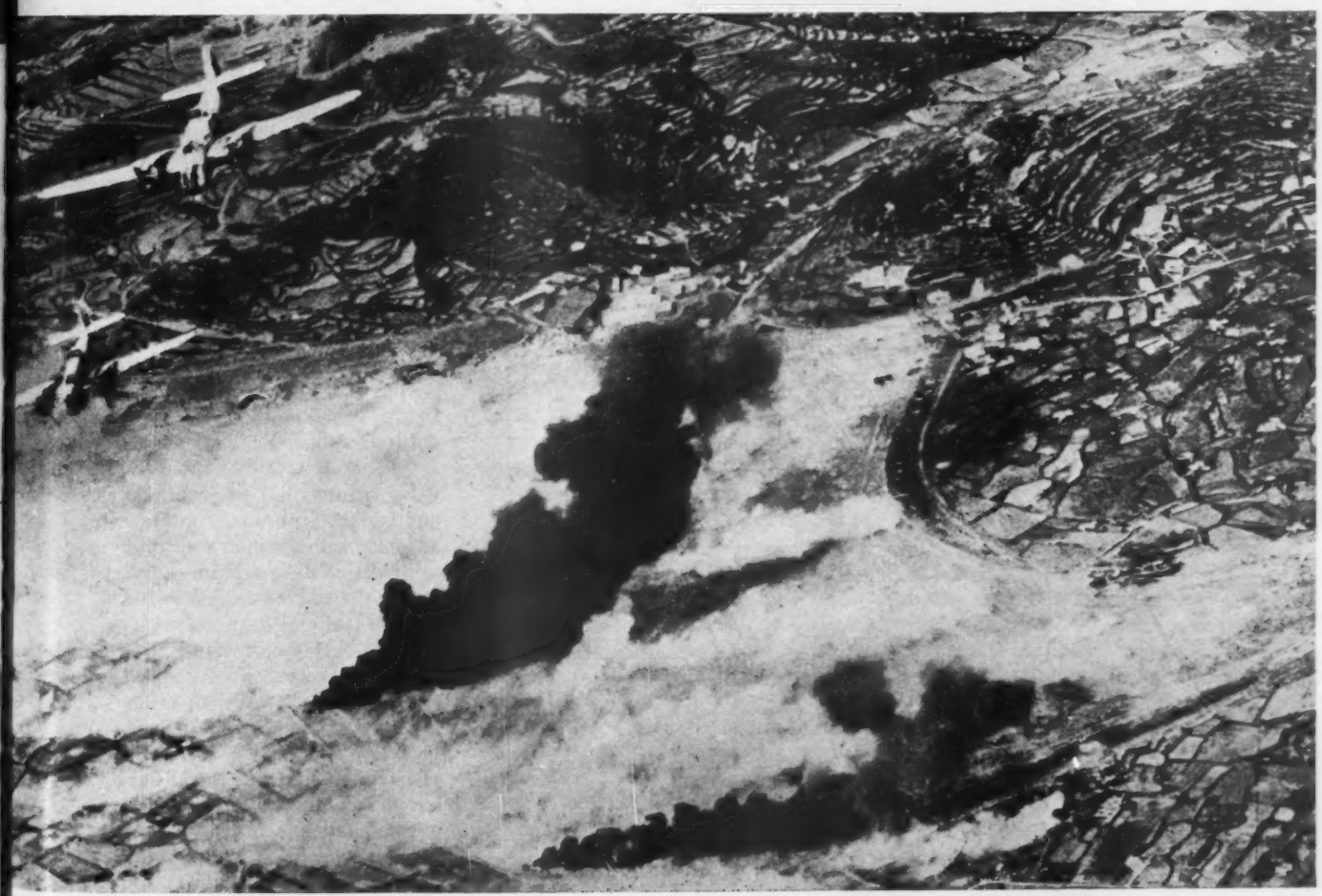
struck now. The enemy is reeling, and if he could be socked hard enough this summer he might not be able to stand up and fight at all next spring. Whether or not he does makes a world of difference in money, property, life, and time—the stuff the living want to conserve, as much as possible, for peace.

It was the great demand for airplanes, from front line dispersion camps clear back through the Army and WPB to the factory manager's office, that brought on the conferences and collations between the Aircraft Production Board and the manufacturers calling upon each to do this and that, or else. But on neither side was there wavering from the firm determination to roll out the airplanes. Appointment of the control and planning committee, for the purpose of balancing up the flow of parts, components, and materials, did not solve all problems, of which aluminum extrusions was most serious. It is safe to guess, however, that the meeting took the aircraft program over its last jolty road to organization. Nothing can give the air commanders all the planes they want this summer. They can only try to deliver the knockdown with the goodly number they get.

While this drive is on for more planes now, some types are being cut back, along with machine tools, anti-aircraft guns, ammunition, and other weapons. One of the fighter plane builders actually got going so good that he worked himself part way out of a job —so far as that specific plane is concerned. Some orders for accessories have been slowed down, and plants have been converted to something else. Engines are plentiful now, and so are propellers; some time, soon or late, these programs will be cut back. The

(*Turn to page* 329)

Vital targets at Lorient are left blazing by daylight-raiding Boeing *Flying Fortresses* of U. S. Army's 8th Air Force. Constant pounding of this Biscay home of the U-boats has greatly blunted sting of Hitler's undersea arm.



With Tunis won, our airmen multiplied their attacks on Italy's several Mediterranean fortresses. Here, Douglas A-20's (left of photo) loose bombs on Pantelleria, an initial objective as sights were lined on Mussolini's end of the Axis. Black smoke, indicating oil fires, is seen arising from edge of airfield. Entrances to underground hangars are seen at far side of landing ground.

Letter to Berlin

Some of the facts Der Feuhrer should know about aircraft production —ours vs. his . . . And some significant considerations at home as the letter is posted.

By **LESLIE E. NEVILLE,** *Editor, "Aviation"*

Dear Adolf:

Charts and statistics are frigid things and the ones we are enclosing should really induce an icy tingle up your spine. Yes, for Mussolini, Hirohito, and you these curves are full of meaning because they are the death warrants of totalitarian tyranny, the blueprints of a new order that you will *not* direct.

For many long dark months we have yearned for the satisfaction of sending you these figures, but we restrained ourselves until the President gave the word. Now we are privileged to present you with a few straight facts dressed up in a form that should help you understand what you are up against.

Do you remember the day when *you* were turning out 2,000 planes a month and *we* were struggling along at a peacetime rate of 800 a month and Congress was afraid that was too many? That was three years ago. Well, since then a lot of aluminum and other things have been knocked into airplanes. We have gone places, while you have remained static. As a matter of fact, the production estimates we credit to your side in these charts are probably too high, thanks to the bomber commands of the Royal Air Force and our Eighth U. S. Air Force. (See Fig. 1.)

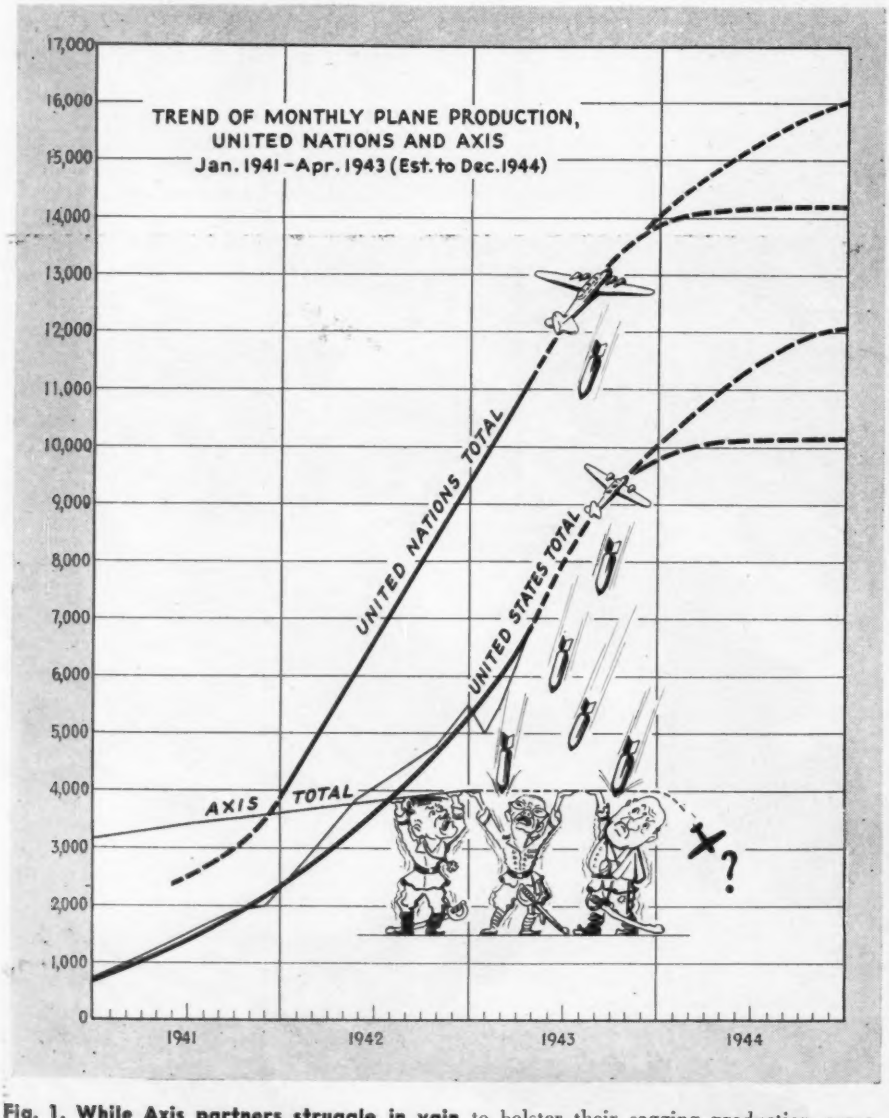


Fig. 1. While Axis partners struggle in vain to bolster their sagging production curve, monthly deliveries of airplanes for United Nations soar.

The President has revealed that we built nearly 7,000 planes in April. That was about three times your production before our bombers really went to town. By the time this is printed our production rate will be greater than that of the rest of the world combined.

Here are some unofficial estimates of the monthly rates of other major nations: England, 2,200; Russia, 1,500; Japan, 1,000; Italy, 500; Canada, 400. These, plus your questionable 2,500, would total 8,100. These figures have been determined with great care and in no instance do they underestimate your Axis ability.

Now let's take sides and look at them in another way: Including our 7,000, they add up to 4,000 for your side and 11,100 for us (see Fig. 2). It begins to look as though you didn't show good judgment in your choice of opponents.

But that isn't all. Our curve is still rising in a steep climb. We turned out our 100,000th plane on Memorial Day—the 100,000th since 1940.

By wintertime we will have added another 3,000 to our monthly rate. And as our bombers increase, your production will go down. Even if it didn't, the monthly score would be 14,100 to 4,000 in our favor—better than 3½ to 1.

As a matter of fact, it will be better than that because we are specializing in the heavy types this season . . . the types that send you missiles rather than missives. Our long-range-bomber production is six months ahead of schedule. You should realize what an accomplishment this is because you have been trying to build some four-engine bombers yourself without very much

success. Some time ago the President said we were turning out more than 500 long-range bombers a month. But the curve has been going up since then. We won't give you exact figures now, but in a very short time we will be turning out enough of these ships to replace normal losses for an operating fleet of at least 1,000 of these useful craft in almost continuous operation.

Pretty soon there will be *heavier* bombers with *longer* ranges. And they will leave little living space around your country.

To show you we are not fooling about this, take a long look at Fig. 3, which is based on the President's poundage figures. That curve leaps right up into your face. Read it—89,000,000 lb. of airplanes produced in 1941; 291,000,000 in '42; 911,000,000 in '43. And 1,417,000,000 more will be ready for you by the end of '44, if you are still around to "take it."

You taught us the game of numbers. You showed us the devastating effects, on a comparatively defenseless adversary, of overwhelming air superiority. You should know better than anyone else how hopeless it is to try to stand up beneath a withering bombardment. Your generals in Tunisia knew when to quit. Why don't you.

—Explosively Yours

THERE is another side to the significance of the charts that is no concern of Hitler's. But it is of direct concern to the manufacturers of aircraft and their components. The big question in the minds of every member of the industry is when production will stop climbing and when and how it will level off.

Peaks, valleys, or sharp cut offs in the curve will have devastating effects on the civilian economy, and it is hoped that the men who chart our production course will be able to foresee the diminution of the need sufficiently far in advance so that the changes in the curve will not be too abrupt.

To appreciate the problems of global war we must consider plant facilities not as the end but as the beginning of long pipelines—to use the current apt figure of speech—running from final assembly through modification centers and thence far out in all directions to most of the 70-odd expeditionary forces in the field. So far, our efforts have been directed chiefly toward the Herculean task of filling all those pipelines as rapidly as possible in order to assure a steady flow to our forces and those of our allies in the many fields of battle.

It is therefore natural that forced-draft efforts be employed in this initial period of highly accelerated production. But sooner or later, depending on the degrees of crystallization of over-all strategy, we will find ourselves in the position where a finished product will drop out of the far end of the pipeline each time a sufficient batch of materials goes in at the factory end. At that time the production curve will level off, at the point of expected consumption. Because of the effect of flattening of the curve upon the policy of manufacturers, it might be well to look ahead and speculate a little on the flattening process in order to help manufacturers plan for the future.

The decision as to when the production curve should be allowed to flatten out is a delicate one. It must, necessarily, be a compromise between the military and civilian viewpoint. It is quite natural and perfectly proper for the military strategist to contend that there can never be too much equipment. Knowing far better than a civilian that the unforeseen events in warfare frequently determine the outcome of a battle or campaign, the militarist desires to feel secure in the knowledge that he will not have to pull his punches because of lack of material.

On the other hand, the civilian economy must be protected in some degree

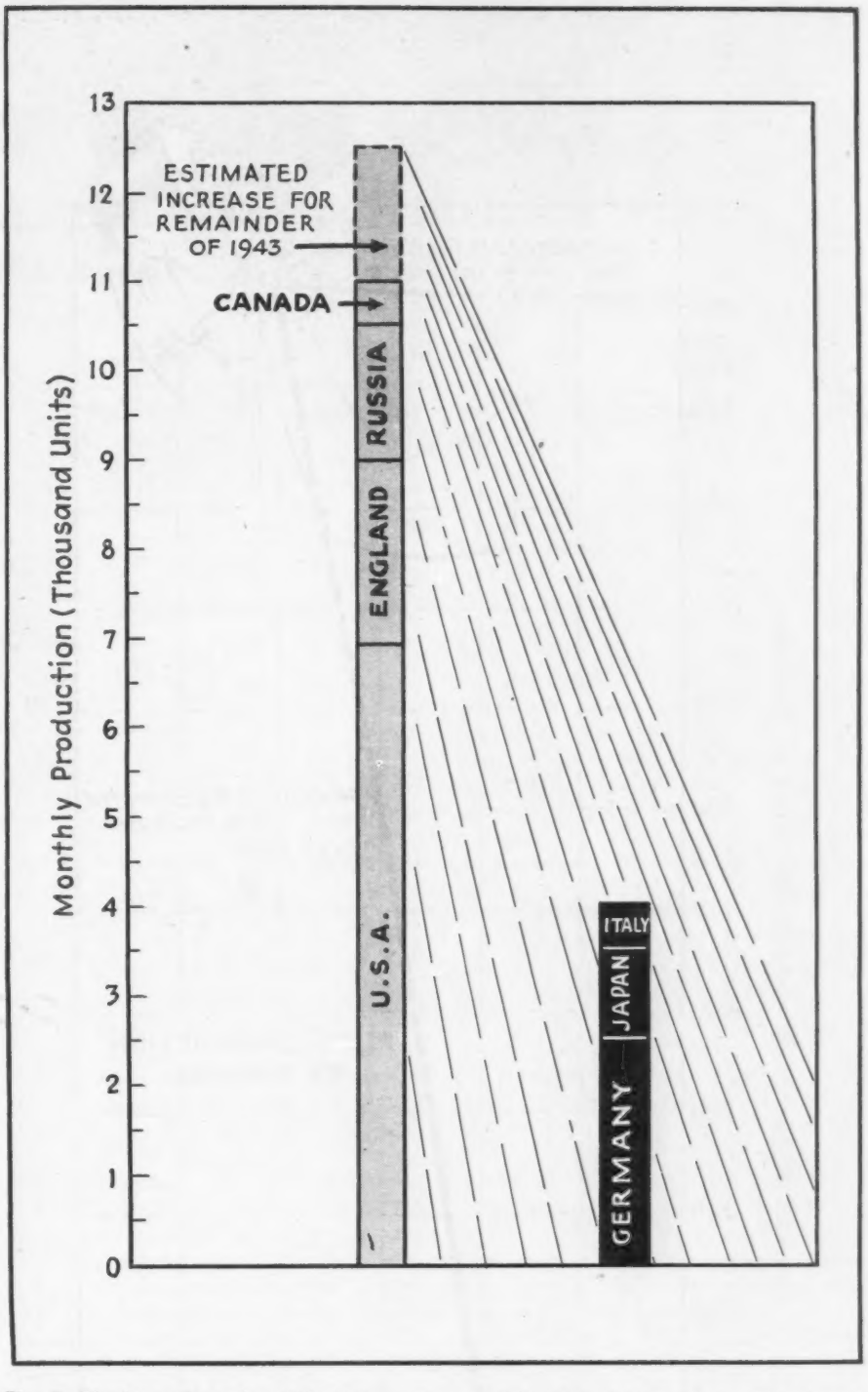


Fig. 2. Shadow of coming defeat is cast over Axis. United Nations' monthly aircraft production puts enemy's performance into total eclipse.

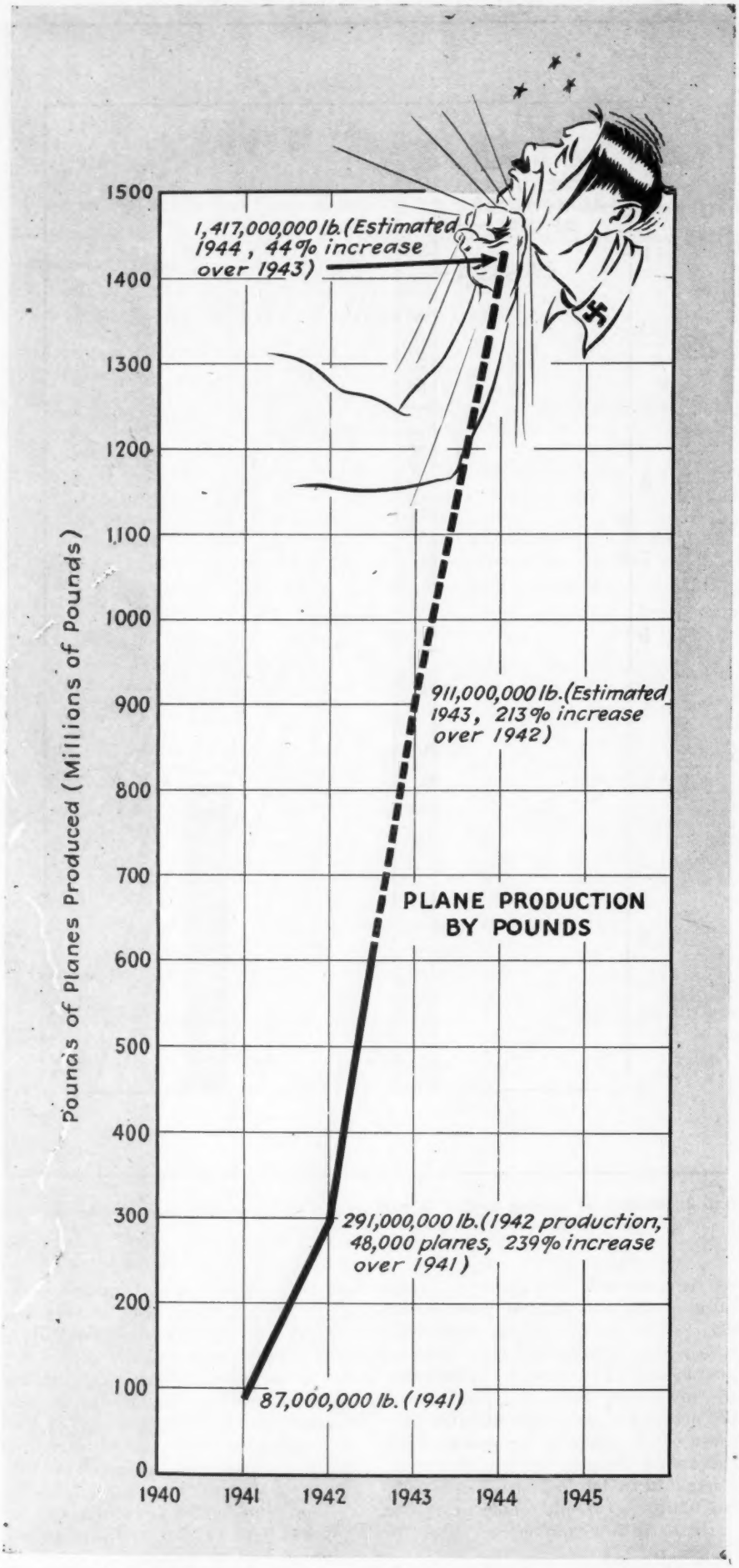


Fig. 3. "Right in Der Fuehrer's face" goes smashing uppercut of America's rocketing airplane-poundage.

against overproduction and overexpansion of productive capacity. The military requirements estimates must be tempered somewhat by the realization that there is a practical limit beyond which demand should not go if we are to minimize the necessary waste of war.

The compromise point between these two views cannot be fixed with absolute rigidity. Provision must be made for variation with the fluidity of war. It may be necessary to change the estimates once or several times. But the actual demarcation must always depend upon a realistic appraisal at a given moment of the fortunes and the prospects of war.

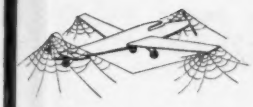
At present there is a strong feeling in high places that it will be unnecessary to provide additional new facilities for aviation production. We should be able to achieve our present goals by the fuller utilization of those plants that have been built and those that are now building or nearing full production. Because of the changing needs of war we may expect that some of these facilities will be used for the manufacture of products other than those for which they were originally intended. Second and third conversions of facilities already converted also may be expected. This will cause local disturbances and dislocations, but "for the long run" it will be better to face these readjustments now rather than to continue to dissipate materials and manpower on projects for which the need has ceased to exist. We have built the greatest aviation production machine of all time. Now it remains for us to feed it with materials and to find the personnel to man it.

The materials problem is not solved, but it is well in hand. Critical shortages will continue to pop up in many embarrassing places. But the output of materials and components is generally increasing and we can see daylight ahead for many that looked black, indeed, only a short time ago. Even the vexatious extrusion problem is now well on the way toward solution.

The manpower situation is probably more serious. Already about one-third of the workers in aviation plants are women. The heavy demands of the armed forces for men and the glamor of military service for women have combined to create a terrific personnel procurement problem for most of the manufacturers. This has not been helped by the confusing pronouncements of manpower policies coming out of Washington. The magnitude of the personnel procurement task is indicated by the replacement tables of some of the manufacturers. A look at them would make you shudder.

Consider the President's figures on poundage of planes to be produced (Fig. 3). Then multiply by two or three

(*Turn to page* 381)



SLUMP . . . OR SURGE

Which Will It Be in Aviation's Postwar Markets?

By H. L. FEDERMAN

VAGUE but widespread opinion prevails that peace will see a tremendous drop in industrial activity—a slump of substantial proportions. And the aircraft builders are most frequently mentioned as the group to be hurt the most.

However, it may be said that there is very little specific substance to this glum outlook, other than the recollection of events following the first world war. The viewpoint has only a very flimsy premise at best, since it overlooks technological progress, basic distinctions in the industrial economy, the role of government, world-wide trends, and other related factors.

Now comes an authoritative survey, based on solid factual material, asserting that instead of a depression we are faced with a high level of industrial productivity in the postwar period. This study, entitled *Markets after the War,* was issued recently by the Bureau of Foreign and Domestic Commerce of the Department of Commerce. Designed to assist marketing analysts in "setting their sights on a common goal of postwar opportunity for American business", this survey appears to be highly objective and far superior to curbstone opinions common in various circles.

What will the pessimists say to aircraft production totaling $442,000,000 for the year 1946? Yes, this is the projection advanced by the Department of Commerce survey, and it is predicated on the assumption that both the war and the immediate postwar conversion will be over by that time.* This would compare with production of $312,300,000 for aircraft during 1940.

Admittedly, the 1946 projection is not of the boom size measure of 1942 and 1943, but it is at a sufficiently high level to assure the industry of a highly satisfactory volume of business. According to the survey's data, aircraft production aggregated but $81,600,000 for 1938, jumped to $141,900,000 for 1939, then, doubled again in 1940. The projected figure for 1946—almost three times that of 1939—would represent a highly commendable showing.

The details as to the types of aircraft to be sold and the types of purchasers are not indicated. But it is important to note that the projected $442,000,000 figure is allocated exclusively to aircraft billings.

This survey cannot be confined to the bare data relating to aircraft with the rest of the findings blithely ignored. The implications go far deeper.

Fundamentally, this report bespeaks a high level of industrial activity after the war. To use figures, the gross national product for 1946 is projected at $165,000,000,000 as compared to $97,000,000,000 for 1940. Now an over-all industrial output of such proportions cannot but permeate throughout the national economy, leaving beneficial effects in its wake. This means a potential acceleration not only in orders for planes but also in other products which may well be manufactured in aircraft plants.

It no longer occasions surprise that the aircraft industry may enter non-aviation markets after the war. If further proof is needed, note the purchase by Lockheed Aircraft of the controlling interest of Pacific Finance Corp., West Coast automobile finance firm. This is an interesting development and bears close examination.

Lockheed obtained control of the finance firm by purchase of a block of 381,205 shares of stock, held by Transamerica Corp. and its associates, at a cost of $15.25 per share or at an aggregate cost of almost $6,000,000. However, upon retirement of shares by the finance firm, Lockheed's investment in this enterprise will total approximately $3,750,000. Loan and discounts of Pacific Finance totaled $6,448,754 as of Mar. 31, 1943, compared with $17,938,650 for the like period in 1942. This illustrates the considerable expansion and leverage possible in the operations of a company of this type, obviating the need for permanent large-scale capital commitments.

During the past year or so, with auto and similar financing in a downtrend, there has been a strong tendency for finance firms to acquire working control of various manufacturing enterprises, this not only making for fuller utilization of available capital resources but also having definite tax economies in filing consolidated tax returns. The Lockheed acquisition reverses this pattern in that the aircraft company did the purchasing. Tax savings may be present, but far more compelling reasons appear to have motivated this deal.

The finance company has offices in a number of Pacific and Southwest states which could be used to finance the purchase of private planes. If so, it is a fair assumption that Lockheed, directly or through its Vega subsidiary, may be planning to enter the light plane market after the war.

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TABLE I — HYPOTHETICAL PROJECTION OF EXPENDITURES FOR COMMODITY GROUPS WHICH ARE LIKELY MARKETS FOR THE AIRCRAFT INDUSTRY

	1940	1946 Projection	Percent Increase Over 1940
	($000,000 omitted)		
Aircraft	$312	$422	35
Passenger cars	2,382	5,718	140
Pleasure craft	6	20	233
Household furniture	871	1,784	105
Miscellaneous durable house furnishings	886	1,526	72
Heating & cooking apparatus	434	814	85
Refrigerators, washing machines, sewing machines	460	799	74
Electrical household appliances	217	389	79
Radio apparatus and phonographs	415	1,100	165
Pianos and organs	47	118	151

Source: MARKETS AFTER THE WAR, Bureau of Foreign and Domestic Commerce, Department of Commerce

TABLE II—BARRON'S STOCK AVERAGES

	Aircraft	Air Transports	50 Stocks
June 3, 1943	34.32	37.94	82
May 27, 1943	35.18	37.28	81
May 20, 1943	34.05	37.81	80
May 13, 1943	33.80	37.62	78
June 5, 1942	27.45	17.84	59

TABLE III—TREND OF LEADING AIRCRAFT EQUITIES

All Fractions Eliminated

	Current Price*	Annual highs 1943	1942	194.	1940	1939	1938
Bell	18	21	18	25	32	37	37
Boeing	18	21	21	25	29	35	36
Curtiss-Wright	9	10	9	10	12	13	8
Douglas	68	74	71	79	95	88	81
Lockheed	22	26	25	31	42	37	38
Martin	21	24	26	32	48	46	38
North American	13	14	14	18	27	29	20

*As of June 4, 1943.

* It is further assumed that 96.5 percent of those seeking employment will have productive jobs and that prices will be similar to those in 1942. Considerable detail as to the methods used by the experts is available from the Department for those who are interested.

Mid-Year Checkup on Aviation Finance

By RAYMOND HOADLEY
Financial Editor, "Aviation"

SALES of 15 prime contractors in the nation's leading war industry showed better than a threefold increase last year—amounting to $3 370,744,680 compared with $1,095,867,240 in 1941. Yet aggregate earnings of these same aircraft companies were virtually unchanged from the previous year.

Perhaps that is the reason stock market prices of aircraft shares have been in a generally downward trend while stocks of the airlines, also the chemical and many other groups, have advanced. The investing public apparently took little stock in prewar Wall Street talk that aircraft would be America's No. 1 war baby marketwise—and with good reason.

It is true that annual reports issued by these companies showed aggregate net profits of $90,171,939 in 1942 against $77,972,881 in 1941. But only a few of these concerns had completed contract renegotiation when their reports were issued. Thus aggregate 1942 earnings, in reality, will be well below the preliminary reports in many cases.

Five of these companies, for example, offered the government renegotiation boards a total of $67,827,000 in settlement of 1942 renegotiation claims. But the boards in these instances were holding out for a total of $104,000,000. And experience has shown that most of the compromising will be on the side of industry.

Much of the money represented by these huge renegotiation refunds would have gone into excess profits taxes anyhow. But enough will come out of stockholder earnings to drag 1942 profits down around the 1941 prewar level.

Besides the renegotiation claims, four companies voluntarily returned $179,000,000 to the government in retroactive price reductions. Other companies likewise initiated large but unpublished price reductions in their current contracts.

Then, too, the 16 aircraft companies shown in the accompanying chart paid out $355,719,000 in taxes, compared with $176,583,000 in 1941, and one-and-one-half times the total business done by the industry four years ago. Ironically enough, this largest war-producing industry has about the smallest tax exemption of any industrial group. That is because its prewar earnings were less than those of most industries.

What does this mean to the patient aircraft stockholders who ventured their capital in the 1930's and received rather meager dividends, if any, while the industry was struggling for its place in the sun? Dividends are the stockholders' bread and butter. Dividend payments for the 16 aircraft concerns totaled $27,017,000 in 1942, a decline of $3,400,000 from 1941.

And in the meantime the bank or funded debt of this group, wholly apart from Defense Plant Corp. facility contracts, increased from $44,199,000 in 1941 to $90,240,000 last year-end. It is substantially higher today—a possible danger signal for an industry that was singularly free from any capital incumbrances except common stock before the war broke out.

What is the composite 1943 fiscal outlook for the aircraft stockholder and his company? It is decidedly mixed at present with all the ifs and ands that are bound to prevail in wartime.

Sales, of course, will show a huge increase again this year, amounting to nearly $20,000,000,000 for all aircraft makers, compared with $6,400,000,000 in '42. Contracts for ordnance and supplies were down 25 percent in the early months of 1943, according to compilations of the National Industrial Conference Board. But aircraft contracts continue at the same volume as in 1942 as Great Britain and the United States prepare to have as many as 1,000 bombers over Western Europe daily by the end of summer.

Contracts for warplanes from Dec. 1942 through Feb. 1943 were valued at 4.9 billion dollars bringing total aircraft contracts to the huge total of 31.6 billion dollars. And the authorized program for aircraft calls for expenditure of another 25.2 billion dollars. No wonder that aircraft takes one-fourth of the war budget and one-seventh of the national income.

At the same time, the government-financed plant expansion program (Uncle Sam owns 93 percent of all new aircraft facilities) is about 80 percent completed. Facilities for making tanks, most guns, and ammunition are, in fact, excessive; hence the cut-back in production of some munitions. Aircraft plant and equipment represent the major industrial front where plant expansion continues. All told, government-financed aircraft plants will come to the handy total of around $3,000,000,000.

So much for the tremendous sales gains to be experienced this year in aircraft.

There are several offsetting factors as far as profits are concerned. Price adjustment officials say that renegotiation will cut profits on 1943 earnings below the 1942 margins. Contracts, they go on to predict, will be subject to closer scrutiny than ever before. And Washington observers are betting that Congress will not repeal the renegotiation law this year, despite its unpopularity in industrial circles.

Meanwhile the Treasury Department feels that industry can stand more corporate taxation. Under the present 40 percent combined normal and surtax and the 90 percent excess profits tax rates corporations as a whole will pay to the government three out of every five dollars of their 1943 earnings. When Congress gets around to writing the annual tax bill next fall, the consensus is that the normal and surtax rates will be upped to 50 percent.

On the other hand there also may be favorable legislation regarding postwar reconversion reserves—a mighty sore spot in the aircraft industry. At present, there is nothing the price adjust-

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PROFIT, DIVIDEND, AND SALES RECORDS OF 16 COMPANIES

Company	Net Profits		Profits Per Share		Dividends		Sales	
	1942	1941	1942	1941	1942	1941	1942	1941
Aviation Corp.	$4,723,894	$2,454,142	$0.82	$0.42	$0.25	$0.15	$45,530,638	$18,680,639
Beech	2,417,819	471,715	6.04	1.18	1.00	None	59,592,953	8,062,204
Bell	4,203,583	1,970,645	11.78	5.55	2.00	2.00	130,763,227	46,414,444
Boeing	5,237,624	6,113,144	4.84	5.65	1.00	None	386,567,316	93,893,090
Consolidated	10,323,779	8,024,882	8.04	6.22	2.00	2.00‡	304,013,649	95,529,050
Douglas	11,054,620	18,176,690	18.42	30.29	5.00	5.00	501,781,984	180,940,110
Fairchild	626,744	541,079	0.60	0.52	None	None	47,080,224	13,802,437
Grumman	1,335,848	1,066,683	2.63	2.10	1.50	1.50	143,155,931	21,858,680
Lockheed	8,163,721	7,461,537	7.59	6.89	2.00	2.00	491,160,471	144,728,153
Martin	6,658,809	5,773,148	6.01	5.24	1.50	1.50	337,556,000	67,237,689
No. American	10,436,413	6,075,954*	3.04	1.77	1.00	2.00	242,595,085	60,865,687
Northrop	3,044,741	484,778†	....	....	None	None	32,983,762	3,407,704
Republic	1,105,061	781,119	1.02	0.69	None	None	.....	.....
Ryan	556,444	669,603	1.27	1.52	0.55	None	19,620,076	8,390,201
United Aire	17,096,842	16,721,381	5.95	6.29	3.00	4.00	518,970,578	298,000,000
Vultee	4,291,140	3,100,735	3.33	2.95	0.50	None	109,772,850	34,057,207

* 9 months only.
† Deficit.
‡ Plus a stock dividend.
Note: Curtiss-Wright Corp. report not issued.

"This baby gets us off to a *FLYING START!*"

FLEDGLING PILOTS are early taught that the speed of the air flowing over their wings —not the plane's speed over the ground—is the measure of their safety from inadvertent stalls. The tell-tale dial of the air speed indicator gives a sure warning. This versatile instrument accompanies a pilot throughout his career, "nursing" him through early training, guarding him in battle tactics, helping solve navigation problems when there are neither stars nor landmarks to steer by. It is an instrument worthy of all the skill its maker can put into it . . . the kind of skill which goes into all Kollsman aircraft instruments, long supplied to military and civil aviation.

THE KOLLSMAN SENSITIVE AIR SPEED INDICATOR *provides the highly precise data required for modern air navigation as well as a constant check on the safe and efficient flying attitude of the plane. It indicates the air speed of the plane to within one m.p.h.*

WHATEVER TOMORROW'S PLANES *will look like or how they will perform, instruments will play a large part in expanding their scope and usefulness far beyond anything we know today. Kollsman engineers are constantly developing new and better aircraft instruments which will help widen and extend tomorrow's skyways for a new era in aviation.*

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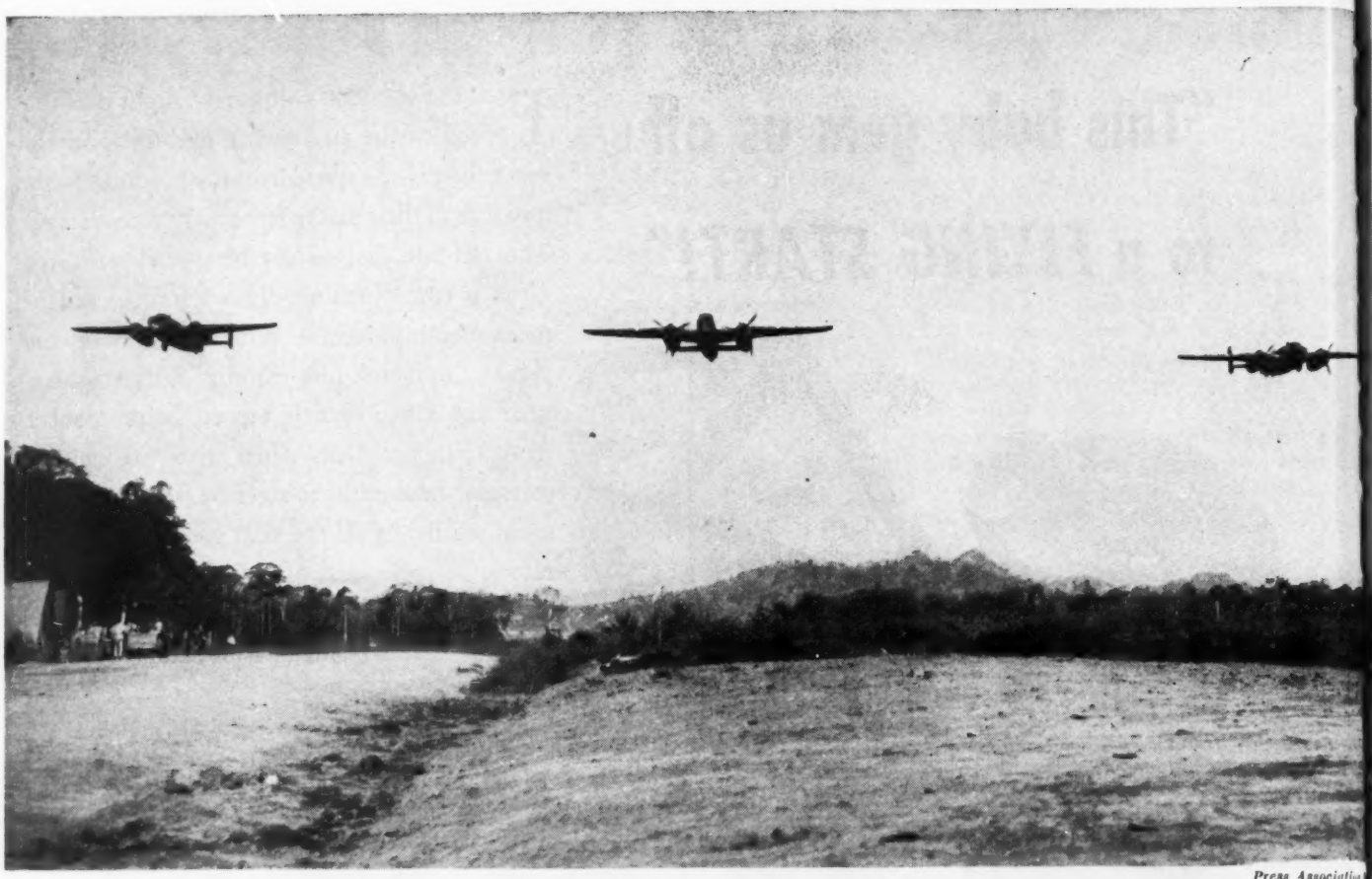


Press Association

"Mitchells in the Pacific theater have already had a great workout, and now they have proved themselves over and over in the most arduous of all conditions—the desert. Due to Allied lack of dive bombers, B-25's have been bombing at extremely low altitudes, where their high speed makes them difficult to hit. They are rated very high because servicing is simple."

Those Claims are Right

By MYLES V. CAVE
"Aviation's" British Correspondent

Our British correspondent gets first-hand evidence affirming AAF's striking combat reports . . . Performances of both English and American planes reviewed.

IN SPITE OF original criticism, *Flying Fortresses* and *Liberators* are ably demonstrating to Germany the might of America in the air. Day after day the B-17's fly out to enemy targets from bases in Britain and return after inflicting heavy damage to important centers and shooting enemy fighters out of the sky by the dozen.

The big claims for destroyed German fighters by *Fortress* crews have been criticized by Luftwaffe radio spokesmen, who tagged them as "exaggerated due to American inexperience." Typical of German radio pronouncements, this rates as part of a new German propaganda policy to instill into German mind and thought what may be called wishful self-persuasion of their harassed peoples.

When the American heavies originated their smashing European attacks with subsequent big claims in fighter kills, there was British skepticism due to the fact that the figures were much higher than those customarily chalked up by the RAF. Some of this skepticism still exists, for the non-technical public does not fully appreciate the greater destructive power of multiple-mounted .50-cal. machine guns compared with British .303-cal. guns. But U. S. public relations officers have done, and are still doing, a great educational job putting over a story that will convince the toughest critic.

These big *Fortress* and *Liberator* scores are also the result of Air Force bomber pilots using a different flying formation from the RAF due to *Fortress* gun locations, which have twice been surprise-altered to the Luftwaffe's detriment. This formation is exceptionally close and is rigidly held even under the toughest fighting conditions. It resembles the "tightbox" formation used by the Martin *Marylands* in the early part of the African campaign. This close-knit formation, together with the angular sphere of fire, concentrated and enveloping, is largely responsible for the *Fortress'* destructive success.

However, this formation does make accurate assessment of shot-up fighters difficult, since it is possible for gunners in four different *Fortresses* to claim a kill. Even so, since these methods have been used we have very carefully

Press Association Photo

"Flying at around 2,000 ft. in close formation, these *Marauders* look more impressive and terrifying to an enemy that any other Allied airplane," states the author, "and their tremendous performance has caused very few losses. An Italian officer of the Regia Aeronautica told us they were beautiful to look at and the most formidable combat bomber they had encountered in North Africa."

checked Air Force diligence in issuing final figures.

In no instance is there any justification for the German radio comments.

Air Force Intelligence Officers have a big interrogation task after a B-17 mission, and their permutations resemble a mathematical cross-word puzzle, with checking and cross-checking of claims from, frequently, more than 500 crew members.

Air Force confirmation of destroyed airplanes is never issued for at least two days after a raid. During that time we have sat in with Intelligence officers and noted their painstaking thoroughness. We consider any criticism of claims can be discounted and attributed to an enemy becoming increasingly scared and worried over the quantitative and qualitative strength of American air power combining with the RAF in the total devastation of German war industry.

U. S. Warplanes in North Africa

Gen. Montgomery's troops, the American Army, and the British First Army have received unparalleled air support from Allied Air Forces flying mostly American planes. *Mitchells* in the Pacific theater have already had a great workout, and now they have proved themselves over and over in the most arduous of all conditions—the desert. Due to Allied lack of dive bombers, B-25's have been bombing at extremely low altitudes, where their high speed makes them difficult to hit. These planes are rated very highly because maintenance and servicing is simple under tough conditions, giving the overworked ground staff less trouble.

Operating at slightly greater altitudes than the *Mitchells,* we have the B-26 *Marauders,* carrying great loads at very high speeds, allowing them to return, reload, and bomb again many times daily. Flying at around 2,000 ft. in close formation, these *Marauders* look more impressive and terrifying to an enemy than any other Allied airplane, while their tremendous performance has caused very few losses. An Italian officer of the Regia Aeronautica told us they were beautiful planes to look at and the most formidable combat bomber they had encountered in North Africa. Criticisms of the *Marauder* are based mostly on complicated servicing and long take-off requirements on frequently improvised airfields. There are reports of modifications to the flaps to improve this.

American fighters, *Lightnings* and *Warhawks,* are prominent in Allied fighter strength. The P-40, now mounting the *Merlin* engine, has again stepped into the front rank of battle planes and is showing itself as a weapon capable of destroying the latest version Me-109's and FW-190's, while heavier German planes have been totally unable to withstand its withering fire from the newly augmented armament.

Lightnings have played a big part in keeping the skies clear for Allied bombers, while their high speed has made them valuable for light bomb carrying and photo-reconnaissance. Performance at altitude is such that the one-time pseudo-insuperable FW-190 is consistently out-shot, out-maneuvered, and out-fought. The P-38's novel combat flaps have been of the utmost value, especially on hurriedly prepared advance fighter fields, while more experienced flyers have been using them in battle to gain maneuvering advantage.

Spitfires, with two-stage super-charged *Merlins,* and a number of specially equipped *Lightnings* have always been kept available to shoot down Ju 86P's or high flying bombers, and the respect the Germans give these planes was shown by the lack of efficient enemy

reconnaissance and the almost total absence of high altitude bombing in the North African campaign.

North Africa was a great proving ground for high-altitude fighters, hence both American and British technicians have learned a lot. In the early days of the *Spitfire IX,* with a rather improvised pressure cabin, flyers suffered from acute psychokymic reactions, but cabin arrangements now have been greatly improved and flyers report no signs of mental nausea after long periods at 40,000-ft. plus.

African fighter strength is not complete without reference to the *Hurricane* panzer-buster. This hard punching fighter in latest form is equipped with two of the largest cannon ever fitted to aircraft. Located under each wing in streamline blisters are 40-mm. guns which, in conjunction with well known *Hurricane* characteristics, have been responsible for the destruction of many German tanks, including that new heavy desert panzerwagen named the *Tiger.*

The RAF call these army cooperation *Hurricanes* "can-openers," claiming that one well directed hit from their cannon is sufficient to immobilize a tank. Accurate aim is made by spotting the target with machine gun tracers before pushing the cannon operating button.

It is interesting to recall early derogatory criticism which Air Ministry experts pitched at Lawrence Bell's 37-mm. cannon in the *Airacobra,* citing slow fire-rate and small capacity for shells. But Bell's pioneering foresight has been completely vindicated and to the U. S. goes the credit for early appreciation of tankbusting requirement in aircraft.

A message has just arrived from the U. S. stating that *Lightnings* with long-range fuel tanks are being flown across the Atlantic. This statement also mentions the *Warhawk* and *Thunderbolt,* saying they are similarly tanked and inferring that these two American fighters are also being flown direct to combat theaters. This is a powerful twin-edged Allied sword not only because shipping space is saved but because airplanes can be delivered direct to battle fronts with minimum delay when requirements are urgent. These long ferry trips are a great tribute to the quality and reliability of Yankee engines. Power plants tuned for maximum output would not ordinarily be expected to function continuously over the long period required by trans-oceanic flight. Investigation into the state of these engines after these long flights reveals only minor adjustments necessary, after which planes are capable of going direct into battle.

Sir Roy Fedden, late chief engineer of the Bristol Aeroplane Co. and designer of a long line of successful Bristol engines up to the current *Hercules* sleeve-valve radial, also has made a very favorable report on U. S. aviation on his return from America.

Extracts from Sir Roy's report have now been released, and he writes with enthusiasm of production methods, "magnificent tooling," and the tremendous strides the U. S. is making technically because "her research laboratories are the finest in the world."

He made one comment which may well be important concerning an American fighter he states will be fitted with a Packard-built *Merlin* engine. Right now *Mustangs* are being *Merlin* powered, and as this is generally known it is not likely that Fedden's report referred to the P-51, so perhaps a new fighter is meant. Alternately it is probable a great deal of research has been carried out by Rolls-Royce and Packard on the Allison-style extension shaft with the possibility of installing *Merlin 61's* in the *Airacobra.*

The two-stage supercharged *Merlin* is going into RAF and AAF fighter squadrons in increasing numbers. American flyers support RAF claims that the *Spitfire IX* is one of the world's finest fighters and tell us the *Merlin 61* is as reliable as earlier 20's and 28's. Thus with the continued assurances that complete technical interchange exists between America and Britain it is a reasonable assumption that Packard will soon be producing these new Roll-Royce motors and that they will be featured in our warplanes.

Merlin 61 Creates New Possibilities

Now that the new Rolls-Royce motor has proved the success originally claimed, an increase in bomber operating altitude is possible. Doubtless British aircraft under design consideration and those possibly already in prototype form are using the 61 and if, as already assumed, Packard goes into production, the power plant may be available for the new series U. S. bombers and fighters we are told will be delivered in 1943.

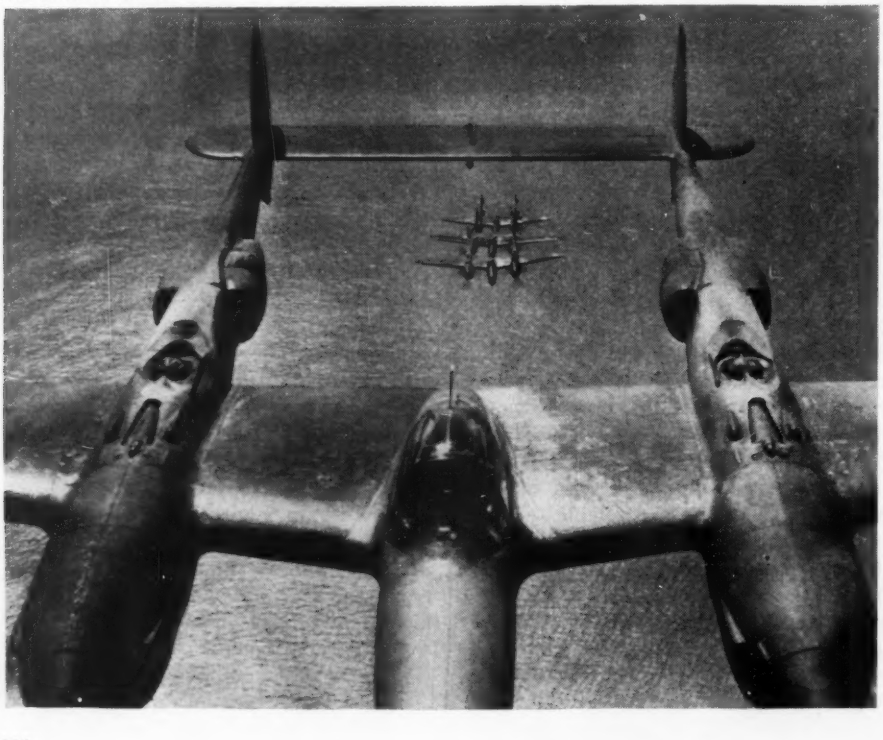
An increase in gasoline octane rating is scheduled in both British and American research programs, which now must be nearing completion. The combination of the 61- and 110-octane gas must be considered as a possible solution to the power problem of the "too-heavy fighters."

The weight increase of the 61 over previous *Merlins* is very small for the added advantages and if 110-octane fuel is standardized, a further increase in power will more than offset additional weight due to increased cooling requirements.

In order to retain the essential maneuverability characteristic, at present so closely controlled by the weight factor, U. S. and British combat plane development seems likely to progress

(*Turn to page* 374)

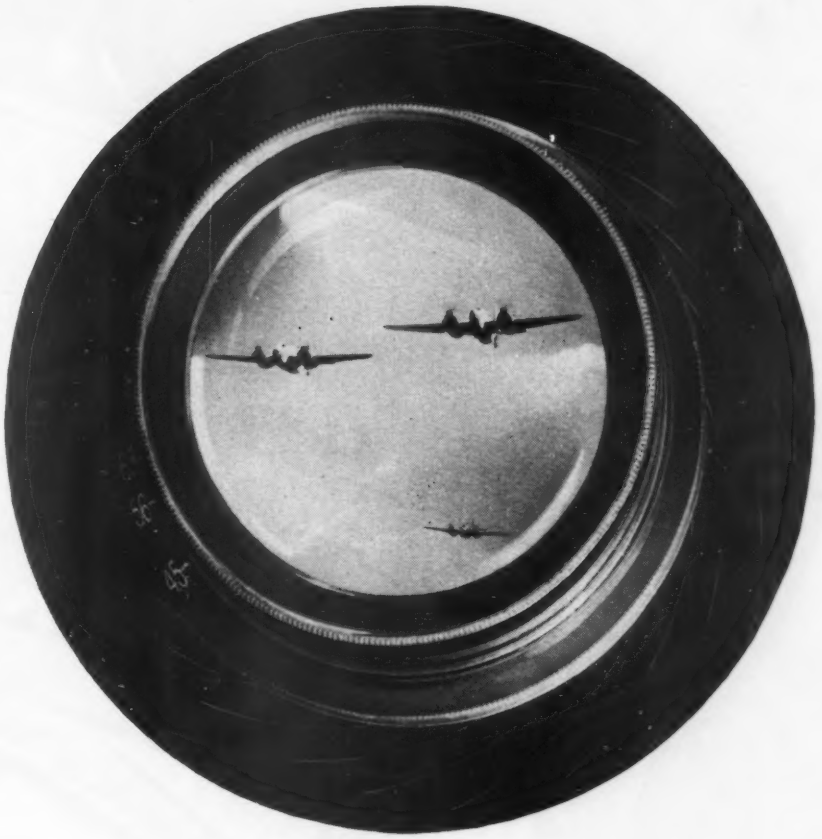
Press Association Photo



"Lightnings have played a big part in keeping the skies clear for allied bombers, while their high speed has made them valuable for light bomb carrying and photo-reconnaissance. Performance is such that the one-time psuedo-insuperable FW-190 is consistently out-shot, out-maneuvered, and out-fought. The P-38's novel combat flaps have been of the utmost value, especially on hurriedly prepared advance fighter fields, while more experienced flyers have been using them in battle to gain maneuvering advantage."

Split-Second Recognition . . . A New Allied Weapon

New system developed by psychologist gives positive identification of planes, ships, and armored land vehicles at speeds up to 1/100 of a second.



LINE UP 100 clean-cut, expensively trained young combat pilots, then pick out 18—and know they'll be shot down either by their brother pilots or their own anti-aircraft gunners.

Such was the tragic situation faced by our British Allies early in this war, simply because neither pilots nor ground forces had been taught to tell friend from foe. Although the American Air Forces were quick to borrow all recognition methods developed by the British to counteract this situation—and had tried several of their own—none offered the final answer.

It remained for a psychologist, Dr. Samuel Renshaw, head of the Psychology Department at Ohio State University, to solve the problem and come up with what has been, till now, literally a secret weapon in the hands of the United Nations. By the Renshaw System of Recognition air and ground forces alike are being taught to recognize not only aircraft, but surface vessels, tanks and even trucks in one one-hundredth of a second.

How many American lives have already been saved by the system cannot be measured, nor can the added number of Nazi and Jap planes shot out of the air because a man didn't have to hesitate to make sure, but the score on both points is impressive.

The system did not result from a deliberate attempt on Dr. Renshaw's part to evolve a new recognition technique, but rather as a byproduct of his intensive studying and testing of the abilities of the human eye. There is a very apt story, even though it may be apocryphal, purported to reveal the beginning of the psychologist's experiments which led to the system.

An artist-friend of Dr. Renshaw's was doing a landscape from the window of a windmill and discovered that the after-image, or visual memory, of the scene was much more vivid than when he had done other paintings. He finally concluded that the windmill blades, flashing across his line of vision and giving him a series of rapidly repeated images, were responsible for this phenomenon. His belief that he saw more in a flash than by concentrating on his subject was psychologically correct.

Dr. Renshaw went back to first principles, eye-training. He knew that the eye could be educated to take in a larger field than normal vision encompassed and that split-second exposure of objects to the eye that had been educated gave sufficient after-image to achieve recognition.

The Navy's Bureau of Aeronautics was more than interested, and immediately arranged to have test courses given at pre-flight schools. Here it was found that the system, despite the fact that it had not been brought to the peak of perfection it now boasts, was 80 percent more effective than methods then employed.

A headquarters school was established forthwith at Ohio State University and training of instructors was inaugurated. Shortly after, the Aircraft Warning Section of the New York Air Defense Wing, commanded by Maj. Charles A. Blackwell, sent men to the Navy school to form the nucleus of a new instructors' unit for the AAF. During an inspection trip Gen. H. H. Arnold visited this school and issued an order under which the Air Forces adopted the system.

The Renshaw system has three fundamental objectives:

1. *To improve general vision effectiveness.* The average person of normal vision does not use his eyes to their full capacity; by proper training he can be taught not only to see more, but to see it in less time.

2. *To train the observer to accurately estimate the number of objects in the field of vision.* This is of particular importance in reconnaissance—to quickly, yet positively, estimate strength of forces.

3. *To train the observer to instantly recognize aircraft, surface vessels and armored land vehicles.* Thus the observer knows the plane or ship by its over-all form without depending on some memorized detail which might not be visible from many angles.

(*Turn to page* 382)

Trail Blazing in the Skies

1933

SKY CABINS FOR WORLD'S FAIR SIGHTSEERS

The cars of the famous Sky Ride at the Chicago Century of Progress 1933-34 were built by Goodyear Aircraft Corporation. While these cars operated on the monorail principle, suspended from overhead cables, the relatively large number of passengers carried made imperative a construction that combined high strength with minimum weight. Calling upon its experience in building America's largest all-metal aircraft structures, Goodyear fabricated these cars from light duralumin alloys. And it is a matter of record that they carried many thousands of passengers without accident.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRCRAFT INDUSTRY

1. *By constructing subassemblies to manufacturers' specifications.*
2. *By designing parts for all types of airplanes.*
3. *By re-engineering parts for mass production.*
4. *By extending our research facilities to aid the solution of any design or engineering problem.*
5. *By building complete airplanes and airships.*

1943

FLIGHT CABINS FOR WORLD WAR BOMBERS

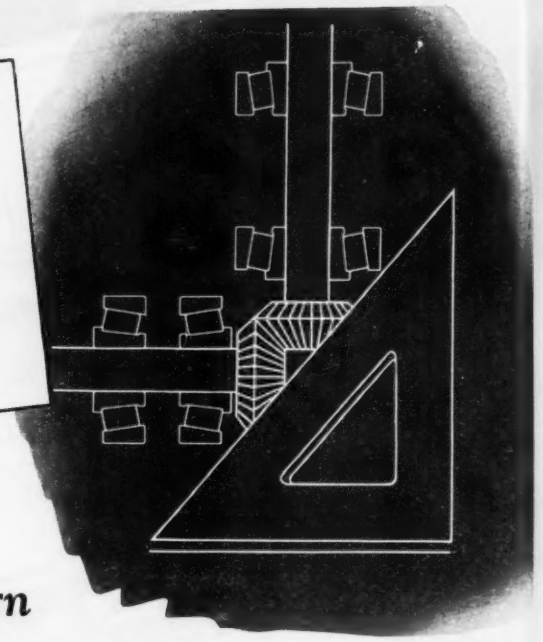
During 1943 Goodyear Aircraft has been producing cabin and flight-deck subassemblies for one of America's largest four-motored bombers. Into these units were compressed all the skill and metal-working technique Goodyear has amassed in nearly twenty years' practice in handling light alloy metals – a background that includes pioneer development in both heavier and lighter than air. Our nation profits from this today in Goodyear's mass-production of U-boat-hunting airships and the swiftest of all Navy fighters, the Corsair.

GOODYEAR

GOODYEAR

AIRCRAFT

DESIGNERS AND BUILDERS
of Planes for Vertical and Horizontal Flight



Where power makes a right angle turn the Timken Bearing is the ideal bearing to use.

Here's Why

PAST PERFORMANCE. There are actually millions upon millions of Timken Bearings in service in industrial and automotive gear applications. Their performance has been outstanding and in these thousands of different *kinds* of applications you find every requirement in bearing design, mounting and performance that will be necessary in your particular field.

SMALL SPACE, LIGHTNESS. The Timken Bearing is a tapered roller bearing. Since load carrying elements form a line contact you get maximum load carrying ability in a given space.

THRUST LOADS AS WELL AS RADIAL. The tapered construction of the Timken Bearing, whereby lines drawn coincident with the tapered surfaces of rollers, cup and cone, meet at a common point, results in not only true rolling motion but also enables the bearing to carry thrust loads as well as radial loads or both together in any combination. This is important in any spiral bevel gear application since gear operation in itself sets up thrust loads. Moreover, Timken Bearings are made in such a wide range of sizes and tapers that you can select the most desirable combination for any given set of loads.

GEAR SETTING AND ITS MAINTENANCE. With Timken Bearings you can achieve in assembly any desired gear setting and the setting achieved can be maintained indefinitely.

QUIETNESS. Quietness is thought to be just as desirable in airplane as it is in automobile service. Moreover, quietness in bearing performance implies smoothness and that is desirable wherever wheels, shafts or gears turn. It was Timken Bearings and our knowledge in applying them that overcame the tremendous bearing problems foreseen by the automotive industry when it decided to use hypoid axles. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN
TRADE-MARK REG. U.S. PAT. OFF.
TAPERED ROLLER BEARINGS

Manufacturing Section of AVIATION

PRODUCTION • DESIGN • RESEARCH • ENGINEERING

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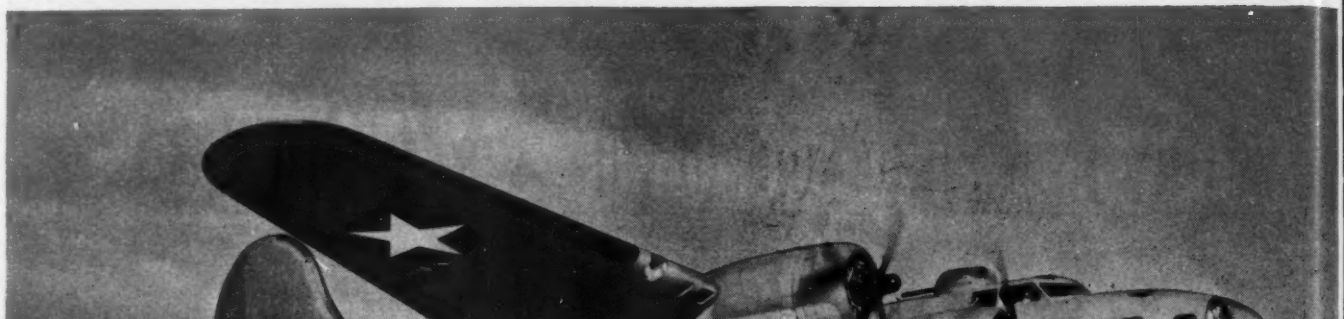
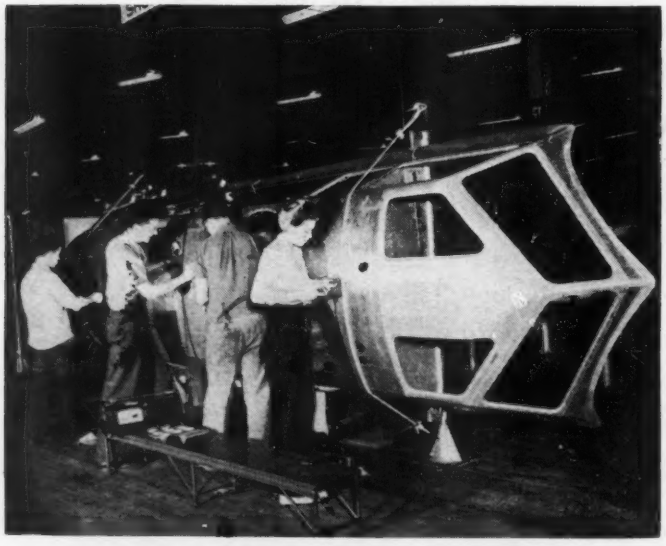


"Fortresses" by Boeing

The Boeing *Flying Fortress*, of splendid achievement in this war's battlefronts, is being built in great numbers, not only by Boeing, but also by two other leading manufacturers. Some of the highlights of the process for building the *Flying Fortress* are revealed in these pages.



Second floor subassembly receives manufactured parts from shops and builds up all components. Cabin top shells are subassemblies, later joined with forward fuselage sections.

ALTHOUGH there are several ways of bringing together parts of an aircraft, Boeing devised a new and somewhat different type of production often referred to as multiline production. This system is predicated on the fact that an aircraft in its final form is extremely extravagant of space. Multiline represents the antithesis of the elongated single production line.

The divergence of methods used by various manufacturers of large type aircraft reflects differences in production philosophy. In Seattle, the Boeing plant was designed specifically for quantity production of large four engine planes. In designing the building and laying out the flow of parts through the various stages of production, thought was directed to the fact that an aircraft of any kind is complicated, and that the building of a military type requires the utmost of flexibility in manufacturing.

Because every square foot of floor space represents a real investment, the most economical type of manufacturing would seem to be one which makes the best possible use of this floor space. In adopting this philosophy, Boeing has achieved an outstanding record of production in terms of pounds of aircraft per square foot of floor space and per worker. By keeping most of the operations under one roof, the flow of materials from raw stock through the sequence of manufacturing operations to the final finished airplane is considerably shortened.

The chief ideas guiding the Boeing assembly plan are: to delay final assembly until major assemblies of the *Flying Fortress* nearly reach the door; to provide all interior installations in the various assemblies before they reach this point; to compact more production in the factory by completing major assemblies as separate units; and, farther back in the factory, to feed the major assembly operations with precompleted subassemblies. This is, in effect, the application of subassembly principles to major assemblies

which are planned and designed to be built complete with all installations and fittings accomplished, so that final assembly is the briefest possible work. While it is like prefabrication, the process involves even more—the precompletion of all major portions of the aircraft before these assemblies reach the final assembly stage.

Source of all parts manufactured in the plant is in the extensive machine and forming shops spread across the rear. Raw stock and small ready made parts are stored along one side of the building. Opposite is the receiving and subassembly station for subcontracted outer wing panels, control surfaces, engines, propellers, tires, etc. A wood shop manufactures plywood flooring, walkways, and ammunition boxes.

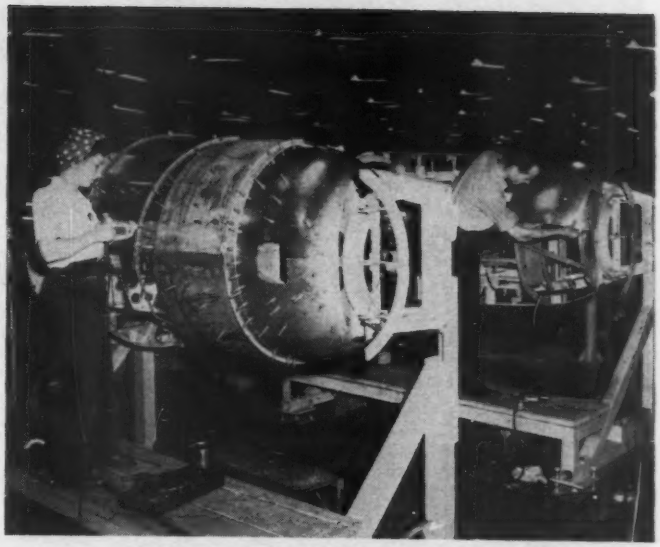
The tool and die shop is located in a building adjoining the fabrication, subassembly, and assembly areas, and is equipped for rapid production of new tools. The tooling system is designed to keep pace with the continual flow of changes which pour in during production of any military aircraft. A new die can be in operation within two weeks of a change request. The philosophy has been to put tooling engineers in cooperation with design engineers who are to draw up proposed changes.

Two things are accomplished by this, the first being that tool designs can be drawn up almost simultaneously with the engineering drawings; second, that changes will be planned with practical tooling in mind. This latter is a whole subject in itself, and much profitable work has been done to guide progressive design thinking.

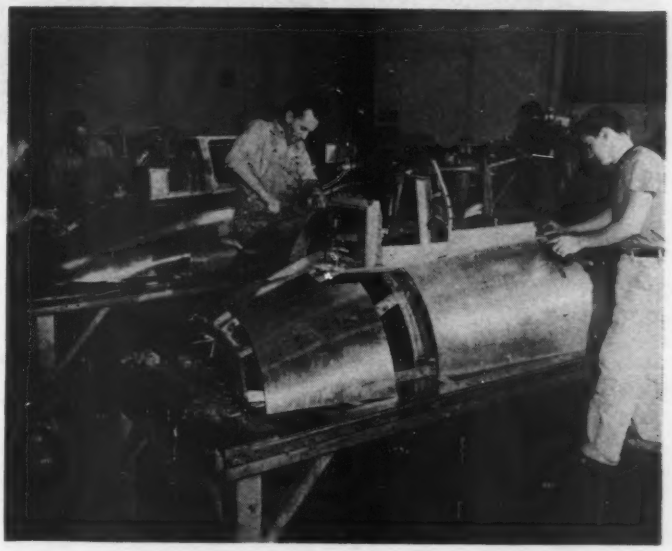
Modifications on current production are controlled as fully as possible in the block system of application, which allots certain changes to be applied with a definite serial number, with another group of alterations to begin on a later designated serial number. This produces uniform ships within groups, which is preferable to modifications being strung out, with each successive plane a little different from its predecessor.

A variety of crank and hydro presses ranging from five- to seven-ton capacity turn out all the smaller formed and perforated parts, while heavy presses up to 5,000-ton capacity handle large sheet and heavy parts. Drop hammers have been practically eliminated, which has speeded production in some cases from two parts an hour to four a minute. Many parts have been redesigned for this type of production, such as the tail gunner's door, which used to require a jig, riveting, and welding. Redesign for draw and form has eliminated 26 parts and considerable assembly time.

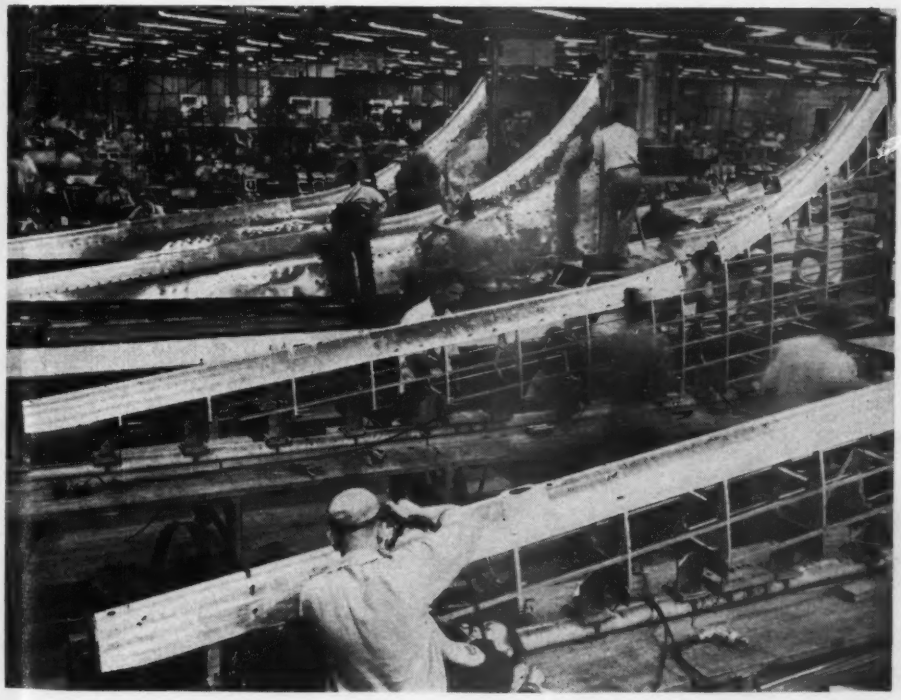
A great advance has been made in retarding action of heat-treated dural. After forming, heat treating of a part causes some warpage. By putting the part immediately under refrigeration, the period of setting up is interrupted. When ready for use, it is removed from dry ice and put on a



Tail turrets are built in two sections in horizontal jigs. Here are the bottom halves going together.

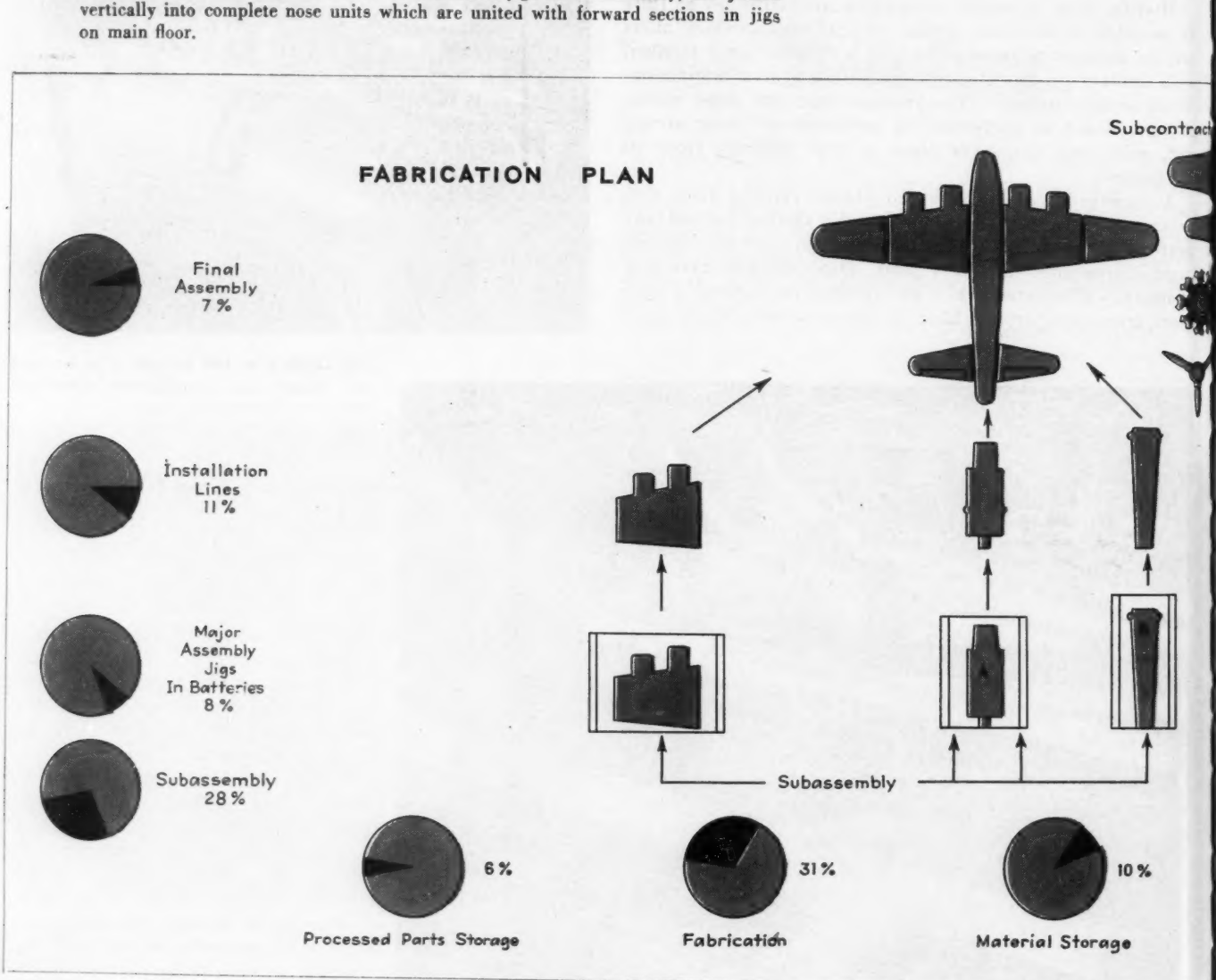


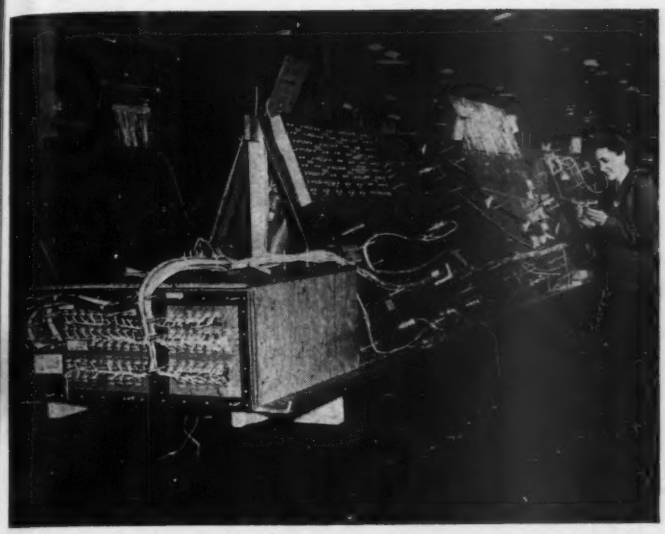
Top section of tail turret. Two sections are joined and installations completed before it is attached to plane.



Characteristic dorsal fin is subassembly, later joined with rear fuselage sections in major assembly on main floor. Special skin clamps speed application of sheet.

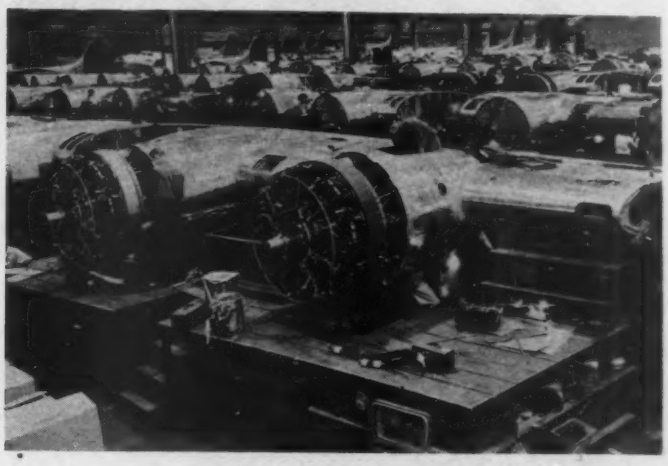
Panels of nose sections are built in horizontal jigs in subassembly, are joined vertically into complete nose units which are united with forward sections in jigs on main floor.





Wiring templates with marked and painted lead patterns have made this formerly slow and intricate job relatively quick and easy. Every wire in circuit is tested before removal by means of terminal plate. Completed units are installed intact in finished sub-sections of fuselage.

Completing stations for wing sections. Only propellers and wheels are added after attachment to fuselage.



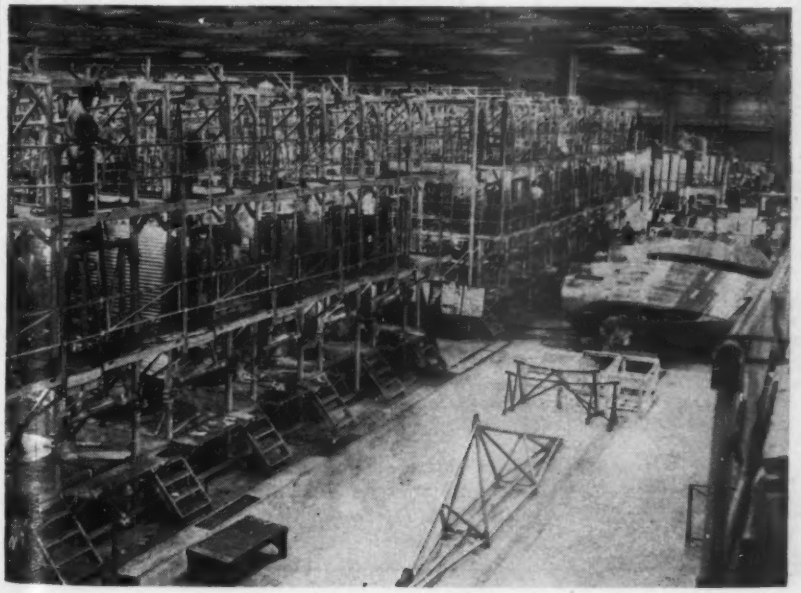
restrike die which trues the form, and a short time after the heat treat sets up to maximum strength.

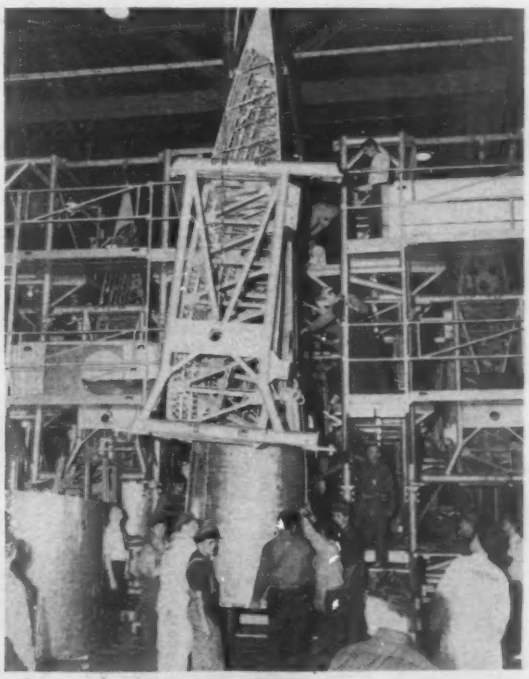
Two of the nearly quarter million specially developed tools are the automatic spot welder for making up large sheets from smaller sections, and a multiple hydro punch press for cutting out slots in the circumferential stiffeners in one operation. The welder performs 62 automatic spot welds a minute, moving the sheets half an inch every 2/10 sec., spending 8/10 sec. on the weld. The circumferential hydro punch, nicknamed "octopus," increases production of stiffeners 45 times. Both have been passed on by Boeing for use by other manufacturers.

In the second floor subassembly section space and time saving really begins, for assemblies worked out here are often as complete as they will be when finally assembled. An example is the wiring procedure, which uses clearly marked wiring panels with colors and lines to mark the leads. Accomplishments are threefold: First is simplification of the process to make use of unskilled help; second is a finished product which requires a minimum of reaching and dragging back and forth in installation, the wiring being slapped into place all in a piece at the proper time; and third is complete pre-testing by means of terminal plates which test every wire of the circuit before removal from the template. With over six miles of wire in 8,000 pieces, failures average less than three per airplane. This system has likewise been passed on to other manufacturers producing the B-17.

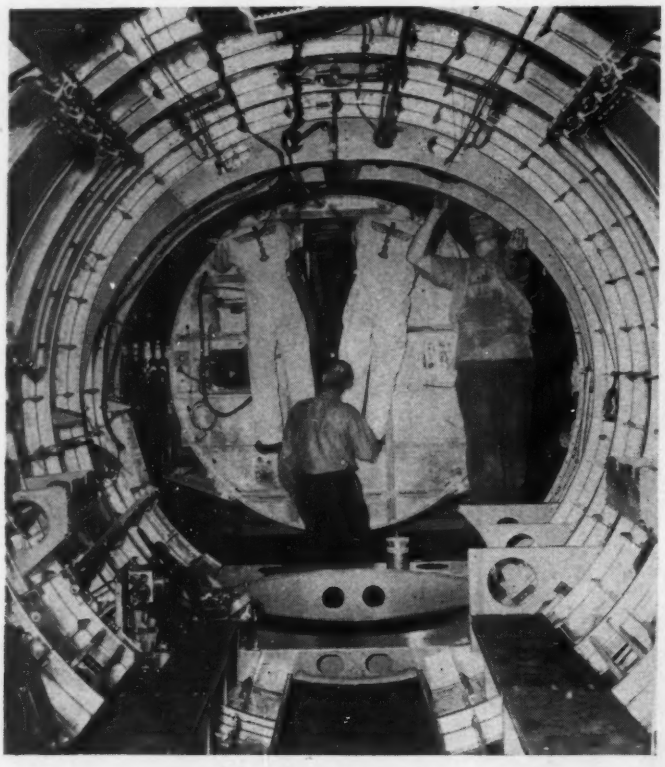
In subassembly, tubing is shaped to necessary contours and flared, then terminals are prepared for connection. Other subassemblies include all the smaller components of the ship. Outer wing panels, all control surfaces, nacelles, wing tank doors, and ribs are subcontracted. Small frame parts for the fuselage are made up as subassemblies, ready to be assembled on the main floor. Cabin top shells, dorsal fins,

Compact vertical wing jigs with three work platforms. Wing inner sections are built complete—except for leading edge, interior accessories, and flaps—before being removed and laid horizontal for reaming holes in attaching faces. Nacelles go in at bottom through hinged platform to be attached to wing.

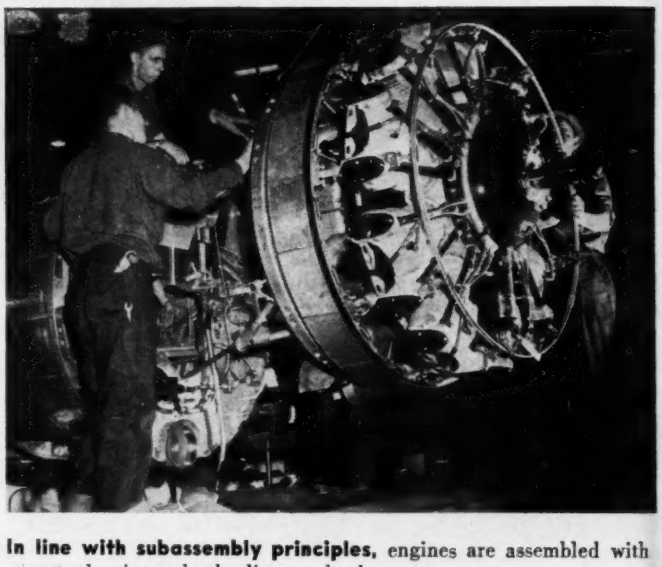




Finished wing section being lifted out of jig. From here it goes to next station to receive controls, tanks, leading edge, coolers, heaters, plumbing, landing gear and engines.

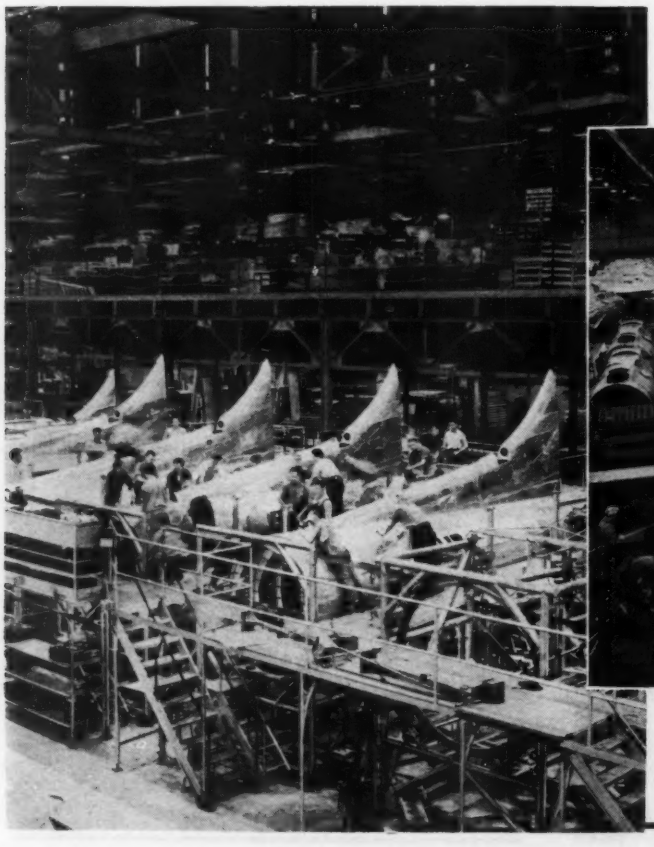


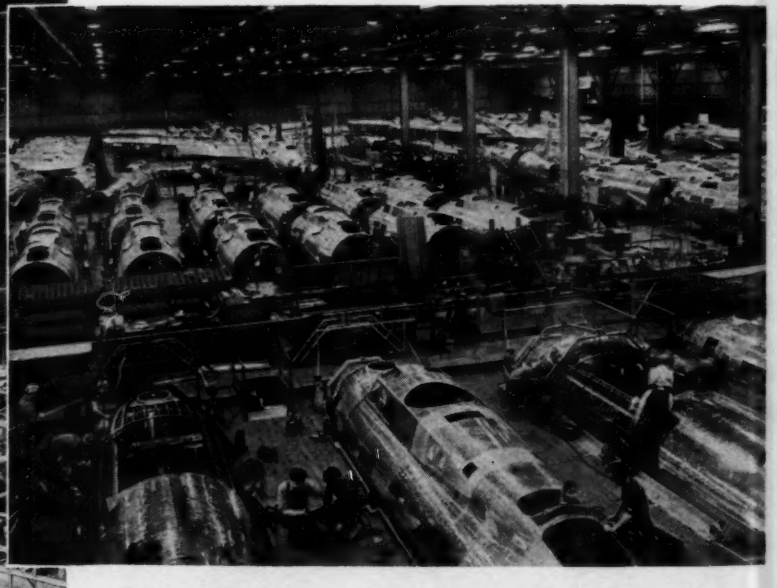
Preparing to join fuselage sections. Note complete installations. Special terminals facilitate connection of lines and wires. Splices at top, bottom, and sides make a strong joint.



In line with subassembly principles, engines are assembled with mounts, leaving only the lines to hook up.

Rear fuselage section jigs. Prefabricated fins are put in to complete structure. In next station ahead, interior installations are made. All units are as complete as possible before final assembly.





Forward fuselage jigs. Two stories give good access, concentrate work, reduce waste motion. Installations are made in area ahead, and in front of that, fore and rear sections are united.

In joining process, rear section cradle is supported on jacks, which adjust to correct height. Sections are pushed together by hand, then spliced and bolted.

stinger turrets, leading edges of wing inner sections, and bulkheads are all made in subassembly. An upholstery department prepares insulation and inner covering for the ship.

Between the fabrication and subassembly areas (in the rear of the plant) and the major assembly area is a processed parts store which, in addition to parts, is occupied by most of the completed subassemblies ready to be incorporated in larger structures. Wing components are stacked beside the wing jigs on the main floor.

There are five main divisions to the major assembly plan —wing inner sections, rear fuselage, forward fuselage, area where the two are joined, and final assembly of all parts just in front of the door.

Both sections of the fuselage are fabricated in two-story jigs lined up across the rear of the floor as closely as efficiency permits, and it can be seen from the illustrations that although spacing is close, accessibility has nowhere been sacrificed. Actually, waste motion is reduced to a minimum because tools and materials are always within easy reach.

The rear section is built in one piece. Previously fabricated bulkheads and dorsal fins come down to be joined with the structures. At the forward end of the rear section, provisions are made for the structural splices which will unite fore and rear sections. These consist of beam splices at top and bottom just under the skin. Sheet joints at these points are left unriveted until the two pieces are united. An additional horizontal plate attachment at bottom further increases strength of the joint.

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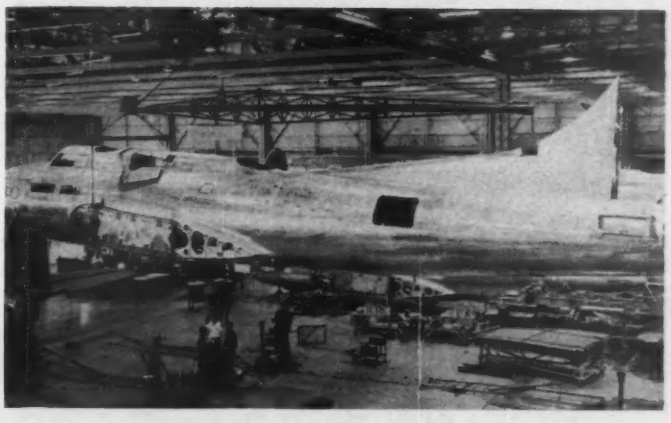
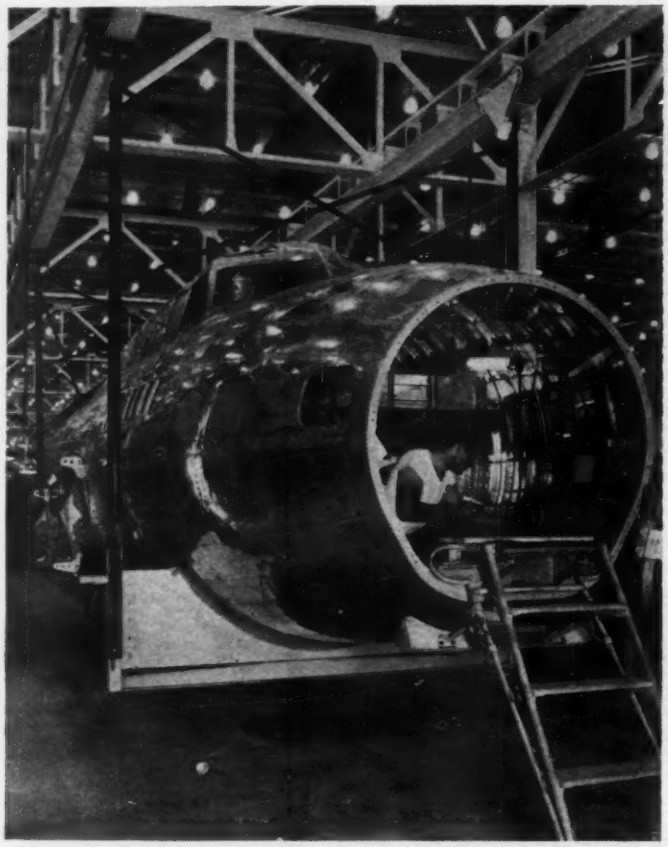


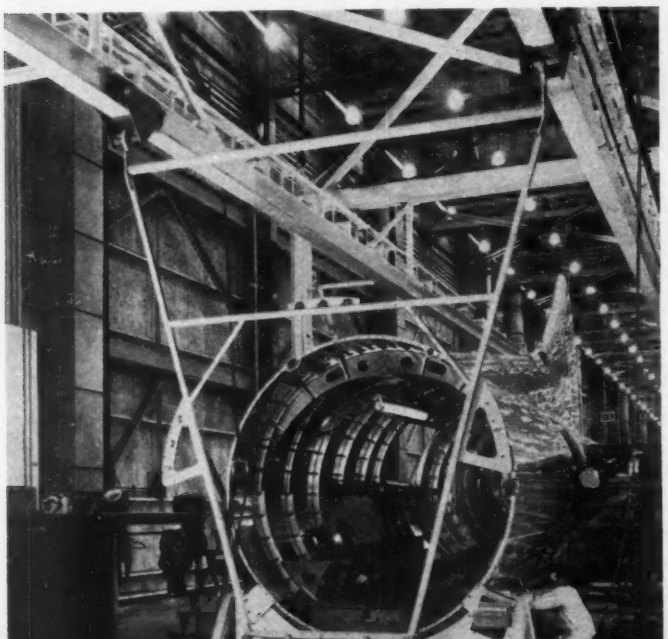
Completed fuselage being lowered, for final assembly, onto jacks which in turn lower fuselage when wings are installed or raise it for attachment of wheels.

Installation of the fin. This part, which is subcontracted, comes in from side at this point. Note that fin is painted. The airplane itself is painted in another building when finished.

With wing inner sections in place, subcontracted outer wing panels follow. Oxygen bottles, seats, wheels, turrets, bomb bay doors, and tail surfaces are added here, propellers farther ahead. All these final assemblies are done in two stations.



Fore sections of fuselages move along assembly lines in cradles suspended from overhead carriers. Note portable fluorescent lighting fixture which also contains electric outlet for hand drills, rivet guns, etc.



Aft sections of fuselage are lifted by overhead crane from stationary tie-together jigs and lowered into cradle for positioning at head of long assembly line. Overhead carriers are then attached and cradle is removed.

Fortresses By Douglas

By GEORGE TULLOCH

Assistant Manager, Long Beach Plant, Douglas Aircraft Co.

Cooperating to let America get there "fustest with the mostest", the BDV brotherhood has poured a wealth of ideas into the industry pool. Here is what Douglas brings to the manufacture of *Flying Fortresses*.

IN PRESENTING what might be called a pictorial preview of the Douglas Aircraft Co.'s B-17F *Flying Fortress* plant, it should be emphasized that this article will cover only those methods, equipment, and systems created by the Douglas organization for the manufacture, quickly and in great numbers, of this famous bomber.

The excellent and proven design of the B-17 and the means for its manufacture conceived and developed by its designers, the Boeing Aircraft Co., and adopted by Douglas, have been covered before in these pages. But, because this article is confined to Douglas innovations, it should not be construed as an attempt to compare and appraise the values of the different methods, machines, and manufacturing concepts of these two companies.

Chief source of this country's high living standard is its ability to produce goods in endless variety, of unsurpassed quality, quickly, economically, and in volume unequalled by any other nation on earth. Among the many abilities of Americans that make possible such production is the ingenuity by which different groups achieve similar or identical results, but with widely varying, sometimes seemingly opposite, methods.

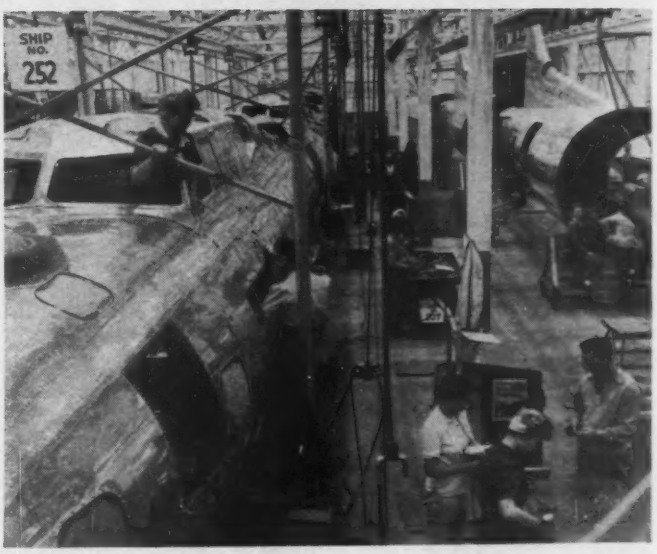
Manufacture of the *Flying Fortress* by Boeing, Douglas, and Vega is another example of this American talent for achieving a desired result, but by widely varying, highly individualistic methods. The Boeing and Douglas systems, for example, might be called opposites. Where Boeing uses a very short final assembly line—several of them—Douglas uses a long one. Whether one is better than the other is a matter of opinion not pertinent to the subject matter of this article. The end results of both systems are identical bombers produced in rapidly accelerating volume and with steadily increasing efficiency in man-hours of human energy expended per ship.

When we were asked by our government to double the capacity of this new plant and launch production of the B-17, we looked upon the request as a challenge and an opportunity seldom afforded an industrial organization. It was an opportunity to create a factory that would include ideas representative of our entire accumulation of manufacturing experience, plus some that were still only theories.

Naturally, with a war in progress and the very life of the nation at stake, the American people were demanding a great volume of planes in record-breaking time. It was to be expected that under such circumstances we would make some mistakes. It is a source of considerable satisfaction to us that subsequent operation of this B-17 plant has proved that we made very few.

Economy was the keystone of our plans, "economy" here being defined as the ability to manufacture a needed product in the required quantities, quickly, and with the least possible human effort. Creating from scratch, as we did, in cooperation with the government, it was possible to decide whether capital investment or time saving would be permitted to dominate decisions. Under prevailing conditions, time saving was chosen, and we built accordingly. There is no question but that the facilities of this plant required great capital investment in plant space. However, the time saving and energy conservation already achieved indicates the choice was wise.

Throughout this plant the physical attitude of each working position is as natural and energy conserving as it is possible to make it. Jigs, carriers, platforms, stands, and racks are designed and located to minimize the drain on both physical and nervous energy and thereby increase personnel effectiveness and goodwill.



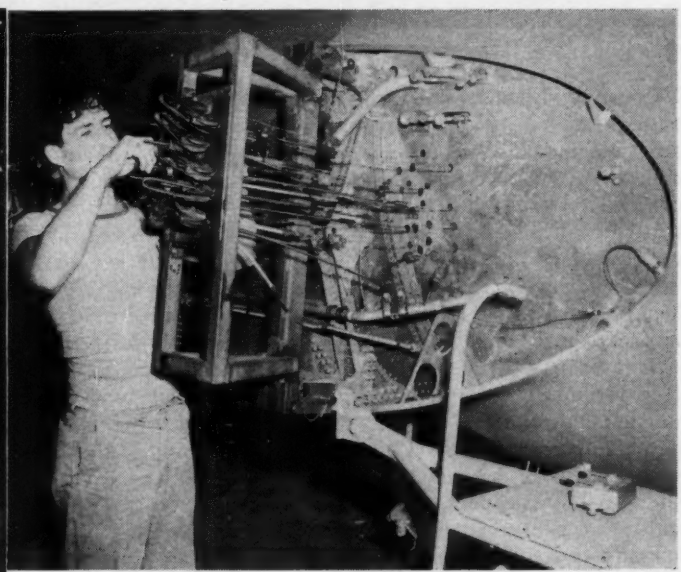
Fore and aft fuselage section assembly lines parallel each other, with benches and electric and compressed air lines between. Elimination of outside congestion of workers is illustrated in this unposed photo. Cradles seen under front ends of aft sections (right) have now been replaced by overhead carriers.

Huge turntable in paint booth permits spraying to be done at right angles to air currents, which are circulated from center of room. Waterfalls at both right and left, in combination with air inlets in ceilings and outlets below falls, keep room free of fumes at all times.

As this is largely an assembly plant, with considerable fabrication done elsewhere, its innovations are chiefly in carriers, dollies, jigs, testing devices, and conveyors, with a few in machines such as those which do multiple drilling operations in already partially fabricated parts.

Tracing the actual flow in the plant, starting with stock storage, we encounter one of the few instances where later developments indicated improvement could be made in the original layout. Because it was imperative to have flexibility, within the limitations imposed by mass production, our original stockroom was a large, centralized unit located in one corner of the main building. It was thought this would permit future shifting of lines, if that was found necessary, without disturbing the source of prefabricated parts.

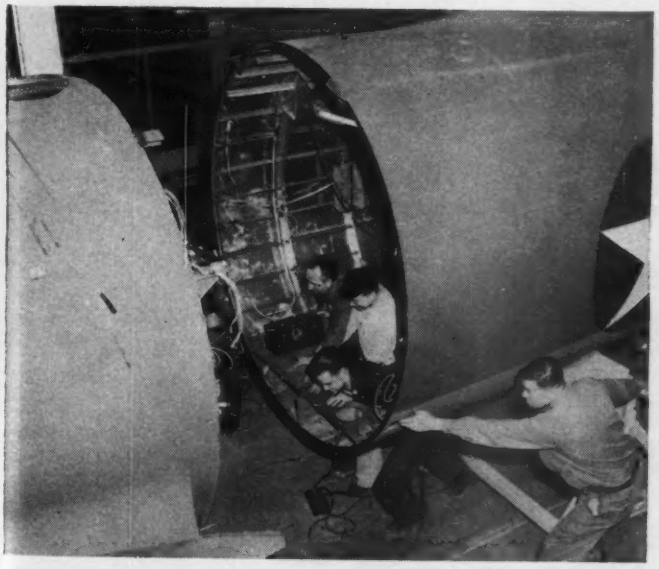
Subsequent developments proved this plan disadvantageous, and a switch was made to decentralized, smaller stockrooms called "receiving points." These are located adjacent to working positions and are the responsibility of the leadman in charge of each position or station. Because the number of parts in each is small, there is less need for reliance on records and therefore less opportunity for error and "lost" material. Leadmen and clerks quickly become familiar



Work platforms, temporarily attached to wing bracket and carrier cradle, ride free of floor and provide easy access to otherwise difficult-to-reach locations on ships.

Testing is done at each station. This jig puts tension on control cables from pilot's cockpit while their length is adjusted to meet the required specifications.

Inner wing sections are assembled in three-level, eight-station jigs. From initial tie-together in first position, where critical points are established, sections are moved past workers for remaining operations. Jobs are so arranged that upper-level workers are never directly over those below.



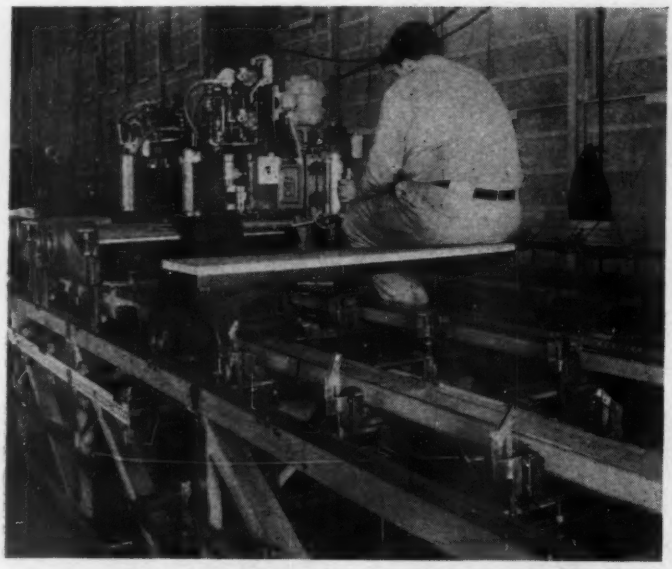
In last station of parallel fuselage section lines, aft section is lowered from overhead carrier and rolled on cradle-type dolly into position behind fore section preparatory to joining.

with the parts for which they are responsible, and they see to it that proper quantities are on hand at all times.

This constant watch cuts the need for large reserves and considerably reduces our inventory. But most important, because leadmen are responsible both for the maintenance of their working schedules and for having the materials with which to maintain those schedules, responsibility is clearly established and authority to meet it possessed. This arrangement has created a self-sufficiency that extends from the individual working positions or stations on up through departments to whole buildings.

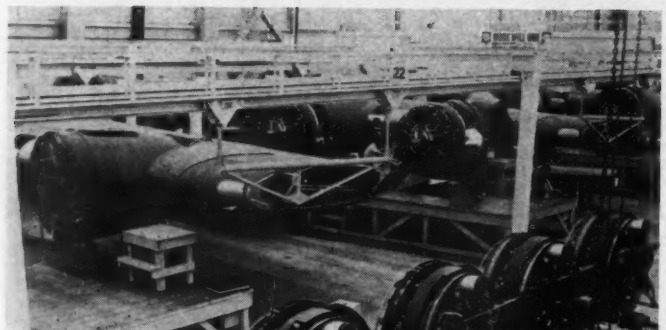
Supervision stems from a supervisor down through assistant supervisors to leadmen. Under each supervisor are three or more assistant supervisors. Under each of these are 15 to 20 leadman, and each leadman has 20 to 30 production workers, about 70 percent of whom are women.

Actual assembly of the ship begins in a more or less conventional system, with the various sections originating in stationary, tie-together jigs. With this initial work completed, the Douglas procedure is first discernible as fuselage sections (for example) are lifted from the stationary jigs and transported by overhead crane to the head of parallel fore and aft section lines. There they are attached to carriers which travel on overhead tracks, through many stations, to the joining position in the last station.



"Fortresses" by Douglas

Douglas-devised gentry drill, operated by man in foreground and another who sits behind drill in background, quickly and accurately drills hundreds of rivet holes through hollow-square spar chord extrusions and mating caps.



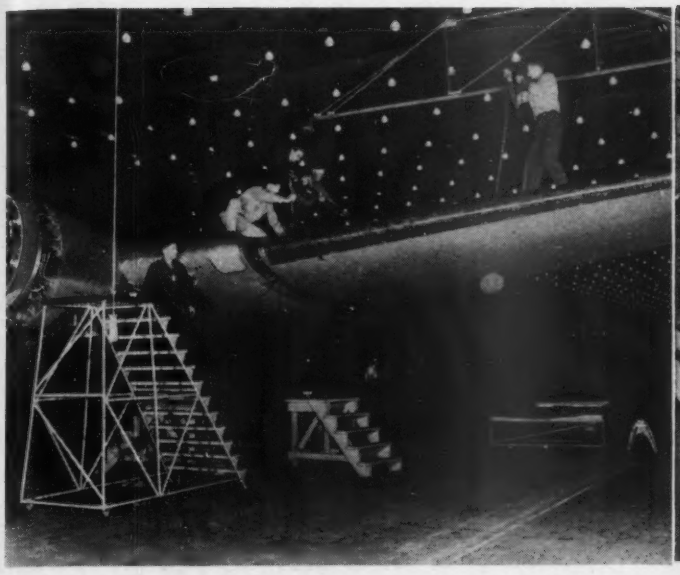
About three-quarters along assembly line, inner wing sections pick up engines, which arrive on dollies and are lifted into position.

By deliberately designing these lines long and with numerous stations we prevented crowded working conditions and thereby increased efficiency and added to worker comfort. With only one, two, or three workers in a compartment, or outside of it, we can arrange lighting, for instance, to suit the needs of each worker instead of forcing some employees to do their jobs under the handicap of shadows or insufficient light. This line was one of the first, so far as we know, to provide fluorescent lighting wherever it was needed, whether inside or outside, with temporarily installed fixtures that remain in place until they are no longer required. These fixtures also provide plug-in sockets for drills, electrically driven rivet guns, and other tools.

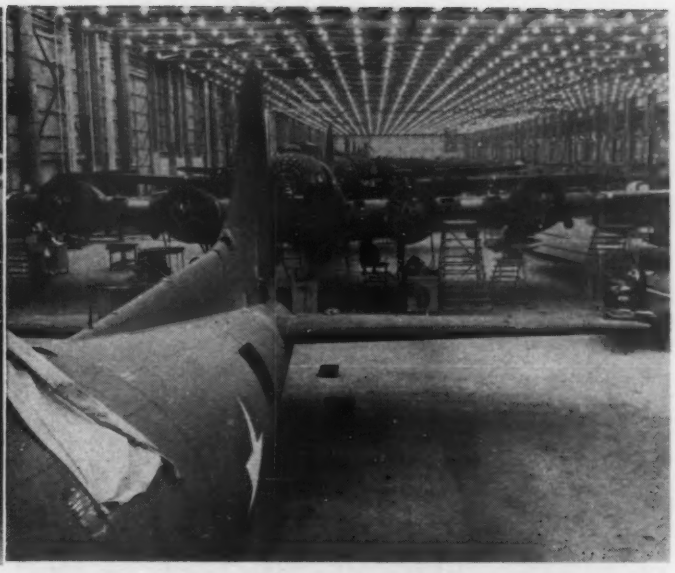
By having the fore and aft fuselage section lines parallel we saved structural steel supporting columns and floor space and made one line of electric and air outlets and work bench spaces serve both. And at the end, fore and aft sections are handy for joining.

This unit, designed by Douglas employees, tests inner wing electrical equipment before wing is joined to fuselage. Test unit takes place of fuselage instruments and controls, simulates their portions of circuits.

Inner wing sections and fuselage come together from lines at right angles to each other. Wings are lifted from overhead carrier line by crane and swung into position for attachment to fuselage. Fuselage rests in same cradle it did on assembly line, the cradle resting on dolly on same axle which attached to overhead carrier.



At first station in final leg of assembly line, outer wing panel is attached. At preceding station, landing gear had been lowered, allowing plane, removed from cradle, to roll backward on its own wheels.



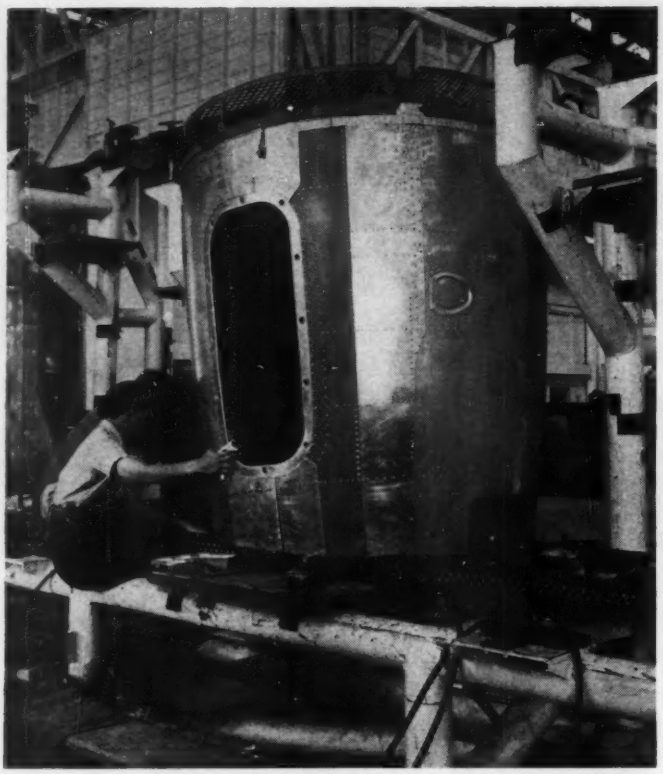
Douglas system for building *Flying Fortress* uses long assembly lines, such as this final leg, where many working stations eliminate crowding, give small crews opportunity to develop high efficiency in their work.

A small item, perhaps, but one of c nsiderable importance, is the rule that line workers cannot carry tools into fuselage sections in metal tool boxes. To back up this rule, there are conveniently located tiers of shelves filled with wooden tool trays which are assigned to workers and in which they lock their tools with their own or company-furnished padlocks. It would be difficult to estimate the possible damage which this provision has prevented, but it has been considerable. Corners of heavily loaded, metal tool boxes may very easily dent or otherwise damage fuselage skin and other aluminum alloy parts, thus entailing costly, time-consuming rework.

About midway on the fuselage lines, the sections enter the paint booth, where still another Douglas-devised innovation saves time and provides worker comfort and health protection. To carry off excessive fumes, waterfalls are provided. Because both ends of the room had to open to permit entry and exit of the sections, these waterfalls could only be located in the side walls. Currents of air from ceiling inlets and suction from outlets below the waterfalls generate a center-to-ceiling-to-side-to-floor circulation that carries fumes and excess paint particles upward and toward the side walls, where they are deposited in the water-falls or exhausted through the outlet air ducts. So well has this circulatory system worked that the white paint of the booth's interior, including the floor, is entirely free of accumulations of camouflage pigment. So effective are these air currents

(*Turn to page* 313)

Handlers roll another Douglas-built B-17F *Flying Fortress* from end of assembly line to flight ramp for servicing preparatory to test flight.



Front spar and nacelles are joined in this Vega-designed jig, are then transferred to a holding fixture for final riveting and pick-up work.

"Fortresses" By Vega

By H. E. RYKER

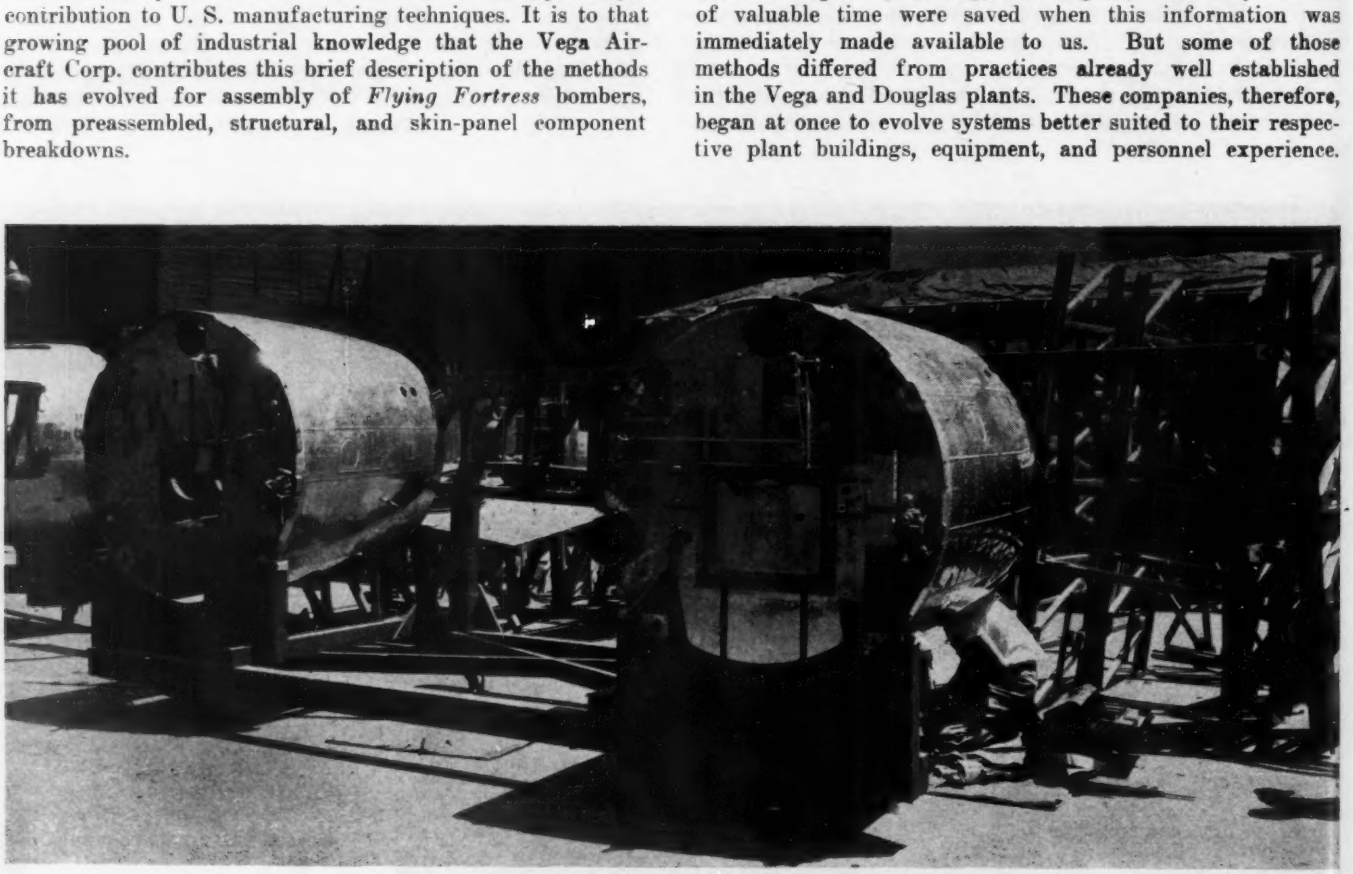
Vice-Pres. in Charge of Manufacturing, Vega Aircraft Corp.

Pre-assembly of structural components permits full utilization of limited space and personnel with minimum of skill and training.

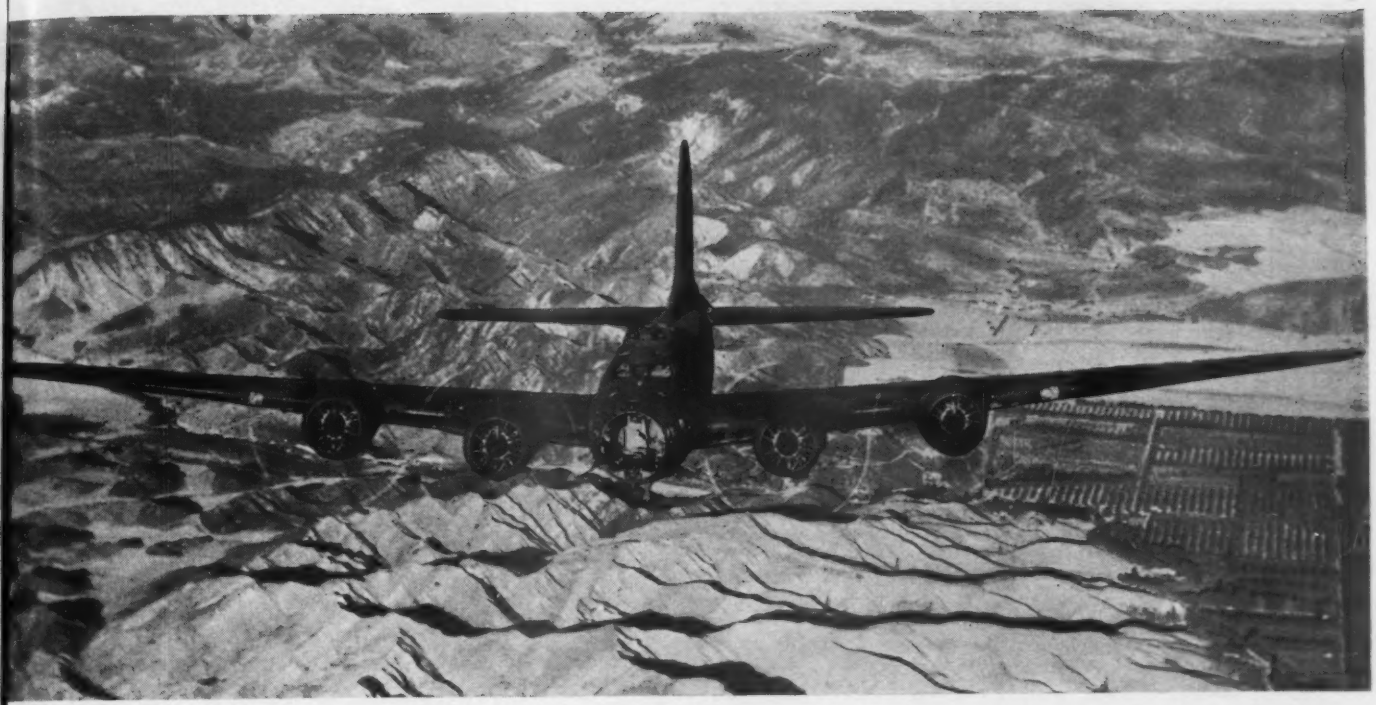
DEVELOPMENT of the "component breakdown" method of assembly to its currently high and steadily increasing efficiency is said to be the aviation industry's major contribution to U. S. manufacturing techniques. It is to that growing pool of industrial knowledge that the Vega Aircraft Corp. contributes this brief description of the methods it has evolved for assembly of *Flying Fortress* bombers, from preassembled, structural, and skin-panel component breakdowns.

When the government asked Vega and Douglas to join with Boeing in the manufacture of *Fortresses*, design, materials, standards, and quantities were fixed, but methods were left to the individual concerns. The system developed at Vega might be described as a blend of the manufacturing philosophies of both Boeing and Douglas with numerous additions that are strictly our own.

Methods for manufacturing the B-17 had, of course, been developed by Boeing, its designer, and many months of valuable time were saved when this information was immediately made available to us. But some of those methods differed from practices already well established in the Vega and Douglas plants. These companies, therefore, began at once to evolve systems better suited to their respective plant buildings, equipment, and personnel experience.



Joined spar and two nacelles get final installatons while on castered dolly on which they will move to next station for addition of leading edge components.



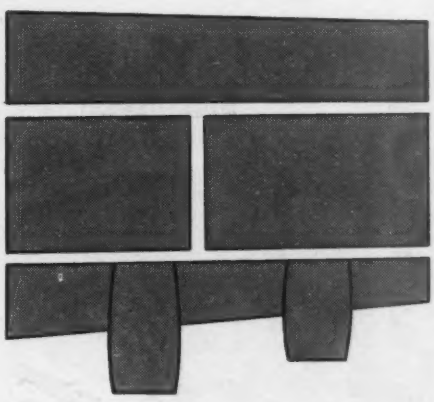
The result is identical bombers assembled by three widely differing methods.

The Vega method, for example, has an inner wing installation line similar to that of Douglas and a final assembly line comparable to that of Boeing. But those words "similar" and "comparable" should not be interpreted to mean "identical", because there are numerous instances wherein these systems differ considerably.

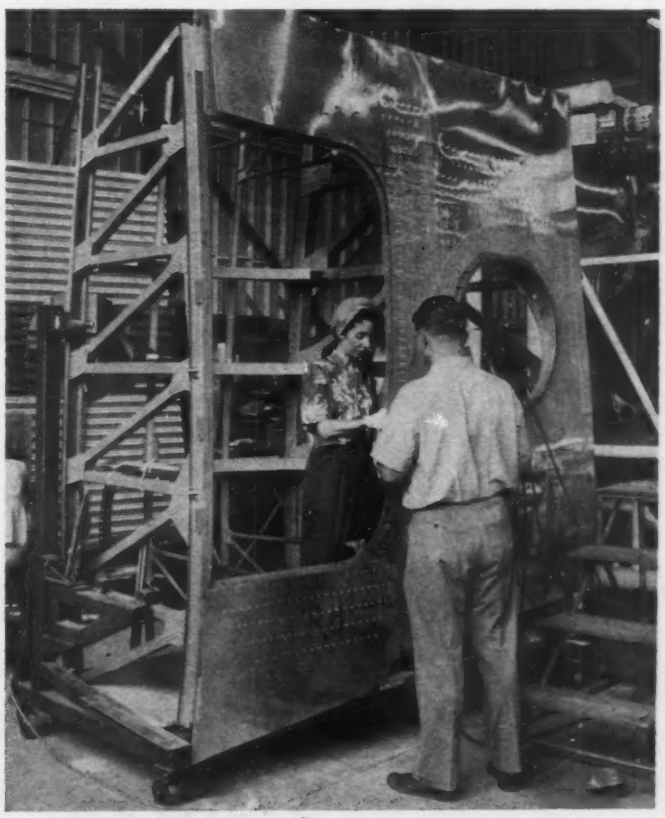
Where Douglas and Vega both use an overhead carrier for the inner wing sections after they leave the mating or master jig, the jigs themselves are quite different; neither is the same as that used by Boeing. Where Boeing uses several short, 4-station final assembly lines, Vega uses two 3-station lines which are even shorter. Of these, neither is like those used by Douglas.

If each of these manufacturing philosophies—Boeing, Douglas and Vega—could be accurately labeled with a single word, the words would be "stationary", "progressing", and "breakdown," respectively. The Boeing system, which is termed "multiline", is based upon jig assembly of large sections which are then completely equipped with installations before being joined to other sections. And the Douglas method starts sections in jigs but, after being tied together, they are attached to carriers for a steadily progressing trip through numerous stations of long assembly and installation lines.

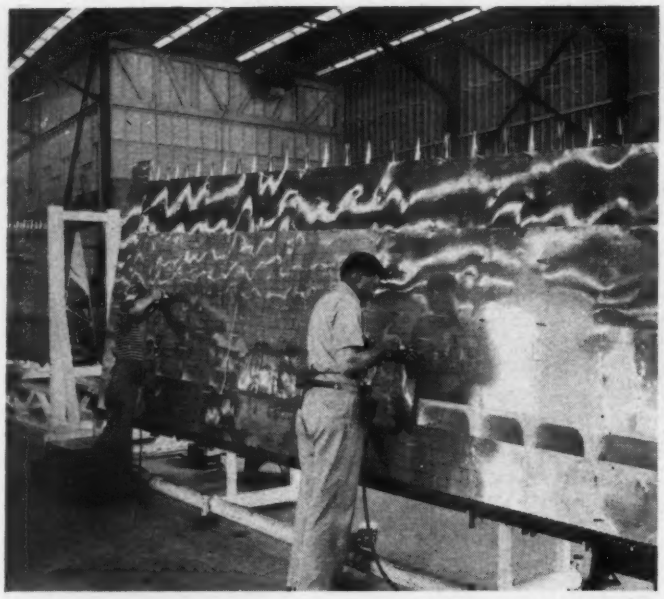
Our Vega method is described as "a pre-assembled, skinned section breakdown system". It is used in manufacture of both *Flying Fortress* and *Ventura* bombers. By this method we assemble skinned panels of the exterior sections and interior structures as components, which are then equipped with as many installations as possible before being joined to other components.



Component breakdown of inner wing sections as assembled in master jigs.



Pick-up crew works on intermediate section of inner wing just after it is removed from jig.

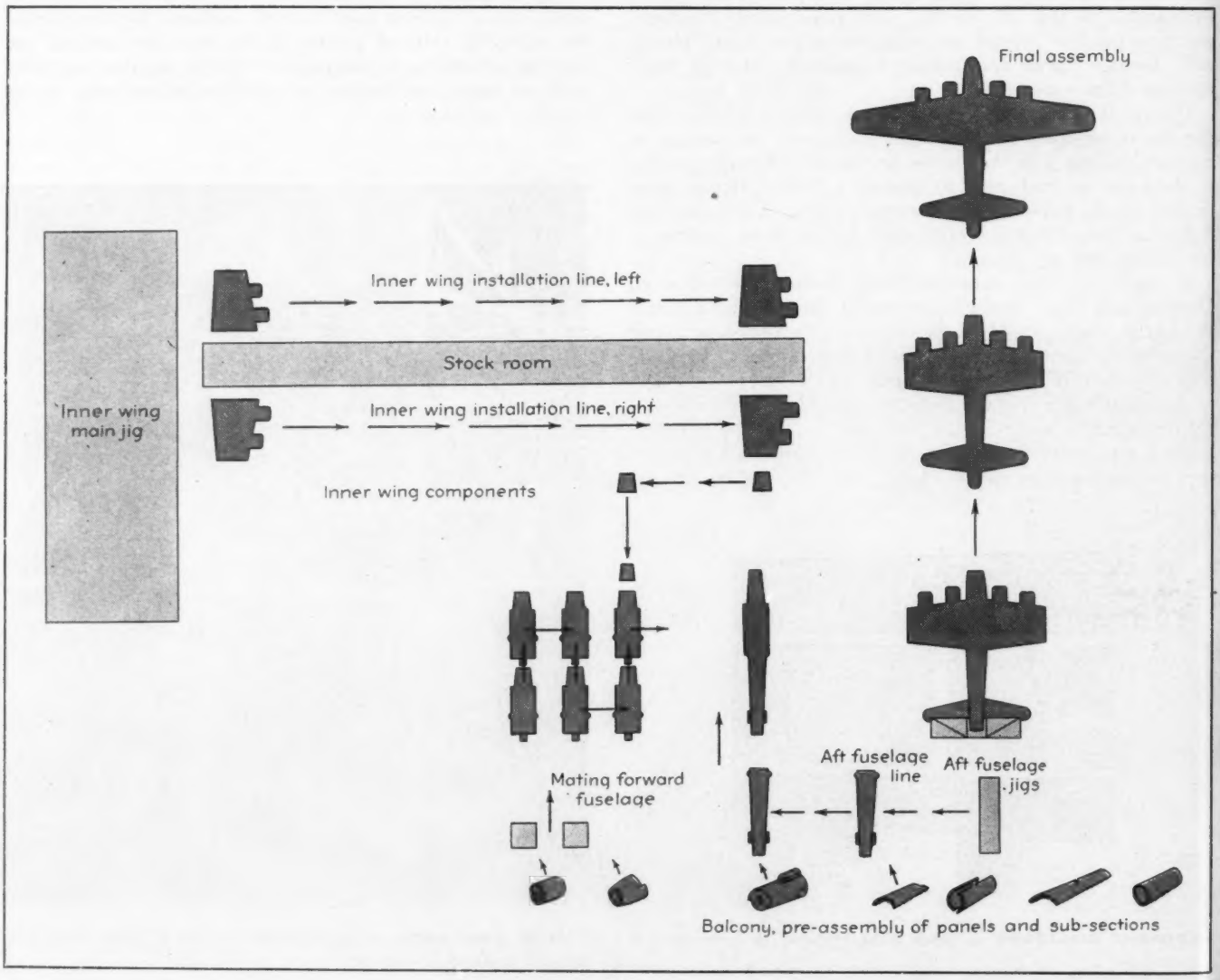


Inner wing trailing edge panels are assembled and covered in this Vega jig. Originally done on third story of master jig, this work now comprises separate operation.

"Fortresses" By Vega

In describing the method it is advisable to point out that all three companies make parts for each other, all three follow identical methods in many instances, and all three rely upon subcontractors for a large number of items. No attempt will be made here to identify sources or to describe methods that are common in all details to those used by all three companies. Rather, this article will briefly cover only those methods and systems created or adapted by Vega.

The pre-assembled component breakdown system of assembling airplanes has long been our manufacturing philosophy, but participation in the "BDV" *Flying Fortress* program has undoubtedly extended it considerably. Plant space has been at such a premium that it has been absolutely imperative that we make use of every foot of it to the fullest. This has been done by creation of large balcony areas, and these in turn have facilitated establishment of small lines for pre-assembly of components and skin panels.



The B.F.Goodrich Airline of the month

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HIGHLY GEARED to the business of all-out war, Eastern Air Lines are doing a tremendously vital job. Night and day their great Silverliners and the transports they operate for the U. S. Army are speeding freight, essential civilian travelers, and military personnel over a sky route that blankets the eastern third of the United States.

Many B. F. Goodrich products fly with the Silverliners. De-Icers crack off any ice that forms on wing and tail surfaces. Expander Tube Brakes improve ground control and help bring planes to safer, smoother stops. And B. F. Goodrich Silvertown Tires mean safer landings and take-offs with capacity loads.

For the vital part they're playing in the war effort and for their many contributions to the advancement of commercial aviation, B. F. Goodrich nominates Eastern Air Lines as "Airline of the Month."

In war or peace

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FIRST IN RUBBER

B.F.GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

WARTIME AVIATION LEADS TO NEW TIRE DEVELOPMENTS

ONLY A SHORT WHILE AGO, aviation's modest needs were well supplied with only a few types of properly engineered tires. Most important of these, both then and now, was a low pressure tire that was tough, yet with plenty of cushioning for transport and private planes.* High pressure tires that were light and compact were available for Navy deck landings and similar services.

But today, as global warfare has carried our planes into jungle terrain, desert sands, and arctic "snow ports," it has been found necessary to develop many new kinds of tires. Here are some of the landing problems and the tires B. F. Goodrich engineered to meet them:

PROBLEM: To provide fast military planes with a wider braking area for quicker, surer stops on all types of landing fields.

SOLUTION: A larger bead diameter was provided in the B. F. Goodrich Smooth Contour Silvertown. Thus, larger wheel rims and greater braking surface were obtained. The wide footprint and non-skid tread of this tire meet the need for maximum ground contact and stability.

PROBLEM: To stop fast planes more quickly and efficiently on icy runways and to take off without skidding.

SOLUTION: Steel coils bonded to the rubber during vulcanization and running around the circumference of the tire bite into the ice and stop the plane quicker, or give ready traction for all ground maneuvers. The new B. F. Goodrich Winter Silvertown is the result.

PROBLEM: To develop a small solid auxiliary wheel for airport operations that would keep cool, even in hot climates and when excessive taxiing cannot be avoided.

SOLUTION: A solid tire in which the tread is *vented.* Venting goes half-way through the sidewall and half-way through the tire, with alternate rows of vents on opposite sides. Some sizes have the aluminum casting vented for extra heat dissipation.

PROBLEM: To provide a tire with High Pressure characteristics, yet which would provide extra ground contact on improvised emergency runways.

SOLUTION: The B. F. Goodrich Channel Tire is built with a high, almost square shoulder that gives a wide, ground-hugging footprint.

PROBLEM: To be ready with the "know how" to build *airplane* tires of synthetic rubber.

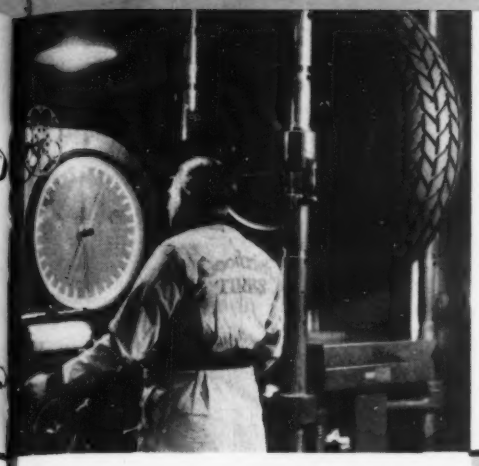
SOLUTION: Synthetic airplane tires were made and tested by B. F. Goodrich and approved by the Civil Aeronautics Administration on March 5, 1943, for use on the air lines.

**The first low pressure airplane tire was developed by B. F. Goodrich engineers, and has become the most famous airplane tire in flying history. It's known as the B. F. Goodrich Low Pressure Silvertown.*

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

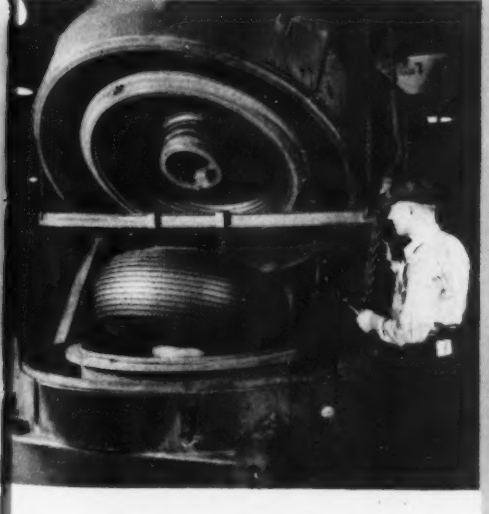
These tires meet the Challenge of

GLOBAL WAR IN THE AIR



1. Here is the Smooth Contour Silvertown, in the B. F. Goodrich testing laboratories. All smooth contour landing wheel tires for military planes have non-skid tread.

2. The B. F. Goodrich plane, Miss Silvertown III, landed on the new Winter Tire during the icy months last winter. Note the tracks made when the steel coils dug into the ice.



3. One of the first synthetic airplane tires for airline service coming out of the curing mold. C.A.A. approved, these tires are now being used on a few planes by leading airlines.

WINTER SILVERTOWN

ALL-SYNTHETIC SILVERTOWN

CHANNEL TIRE

SMOOTH CONTOUR SILVERTOWN

TAIL WHEEL TIRE (VENTED)

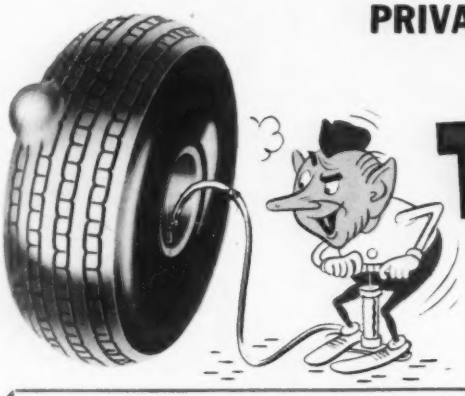
In war or peace

B.F.Goodrich

FIRST IN RUBBER

NEW CATALOG SECTION: A new catalog section, giving the complete line-up of B. F. Goodrich tires, including data on sizes, capacities, weights, contact areas and other information, is just off the press. Write for your copy today. B. F. Goodrich, Aeronautical Division, Akron, Ohio.

PRIVATE GEORGIE GREMLIN WENT HAYWIRE ON THIS



TIRE SERVICE QUIZ

CAN YOU SCORE 100%?

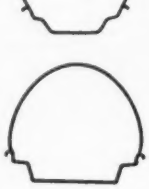
(Pick correct answer from a, b, and c)

1 **The aircraft tire shown in cross-section is . . .**

a. Streamline type.
b. Low pressure type.
c. Smooth contour type.

2 **This one is . . .**

a. Streamline type.
b. High pressure type.
c. Smooth contour type.



3 **All tires and tubes should be properly balanced because . . .**

a. Improper balance spoils the airfoil.
b. Improper balance causes vibrations; uneven tread wear.
c. Improper balance endangers the plane's flight stability.

4 **Proper balance is achieved by . . .**

a. Weighing tire and tube carefully before installation.
b. Placing balance mark on tube next to red dot on tire.
c. Consulting regulation balance charts.

5 **Boots or casing patches should be used only for emergency repairs because . . .**

a. They're apt to block the valve core.
b. They cause serious tube checking or cracking.
c. They cause unbalance, uneven tread wear, and may cause an injury beyond repair.

6 **After a tire is mounted it should be inflated, deflated, then reinflated because this process . . .**

a. Permits the tube to assume its proper contour within the casing and gets rid of wrinkles.
b. Seats the flange.
c. Loosens the valve core.

7 **The Drop Center Rim has a well or depression because . . .**

a. It makes the rim stronger.
b. It permits mounting and dismounting.
c. The increased air chamber increases carrying capacity.

8 **A valve fishing tool is used to . . .**

a. Clean out valve stems.
b. Locate lost valves at night.
c. Keep valves from slipping through valve hole during mounting.

9 **Locking rings should be properly seated before air pressure is applied because . . .**

a. Poorly adjusted ring can fly off and kill somebody.
b. Poorly adjusted ring cuts into tire.
c. Poorly adjusted ring gives false pressure reading.

10 **Approximately how many B. F. Goodrich Aviation Products are being used by our armed forces?**

a. 80. b. 47. c. 25.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-b, 2-c, 3-b, 4-b, 5-c, 6-a, 7-b, 8-c, 9-a, 10-a.

This is one of a series of maintenance quizzes prepared for ground crew trainees of the U. S. Army Air Forces Technical Training Command. It is our hope that this series will help all maintenance men get maximum service, safety, and efficiency from military, commercial, and civilian aviation equipment.

B. F. GOODRICH AERONAUTICAL DIVISION, AKRON, O.

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

Roughly, the system assembles components and panels on balconies and lowers them to the main floor for joining on the final assembly lines. Carried to the extreme found necessary here, this erection of balconies has virtually created a building-within-a-building and has made it possible to so increase our production volume that the government has several times "upped" the quotas originally allotted to us.

Let us begin on consideration of Vega variations in *Fortress* manufacture in the wing department. Here, at the starting point of inner wing assembly, the method is "strictly Vega" in that neither Boeing nor Douglas uses it.

First step in inner wing assembly comprises joining of the engine nacelles to the virtually bare, main or leading edge spar sections. With a spar truss placed on its side in a specially designed jig, two pre-assembled nacelles are seated vertically on it, critical points are established, and the assembly is firmly riveted in place. To save jig time, the final riveting and initial pick-up work are done after removal from this mating jig, while the joined assembly is mounted in a stationary holding fixture. With that work completed, the assembly is transferred to a dolly where additional pick-up of non-critical parts and equipment is accomplished.

From the dolly, the leading edge section is transferred to the three-story master jig, where the inner wing section is assembled while in a vertical position, nacelles down.

Three other sections of the inner wings are also pre-assembled in jigs where critical points are established. They are then moved to holding fixtures for pick-up work and preliminary installations prior to transfer to the master jig.

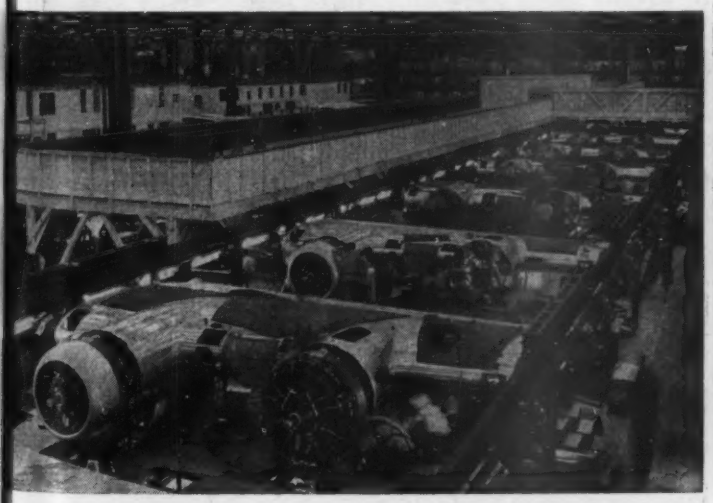
Section No. 2 containing spaces for feeder tanks, supercharger door, and landing gear well, is placed on the leading edge section and joined. Next the No. 3 section, containing the main fuel tank space, is placed and joined. Both of these sections are connected by workers using a second floor level of the master jigs. The No. 4 section, or the trailing edge, on which considerable assembly has previously been done in the master jig, is the last to be attached. Using the third floor level of the jig, workers have completed assembly of this section after it was joined to the balance of the inner wing section. This work is now being shifted to other jigs and hereafter only the actual joining operations will be done in the master jig. Plans for the jig were obtained from Boeing, but removal of assembly work formerly done on the third level is a Vega variation.

After the inner wing sections are joined in the master jig, they are removed by crane to hydraulic jack-equipped handling fixtures which are used to shuttle them to the first stations of overhead carrier lines. This fixture, too, is a Vega development.

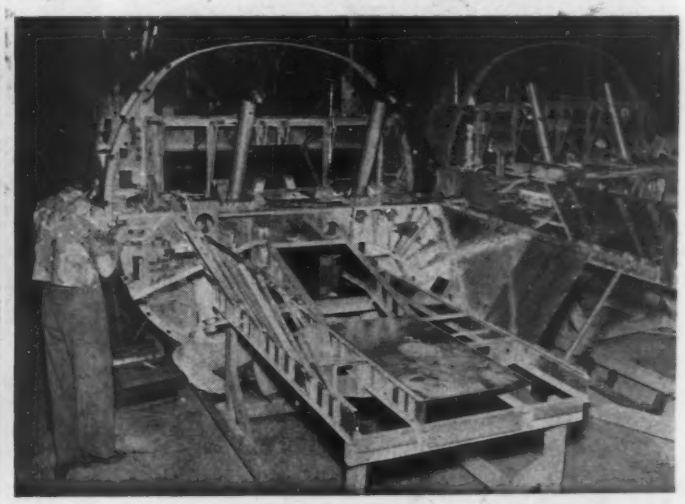
Inner wing final assembly lines—one for port and one for starboard sections—are similar to lines used by Douglas in that there are two of them side-by-side and they are of the overhead type that carry sections over a series of working platforms. They differ in that sections are carried leading-edge-forward, instead of the reverse as at Douglas; only installation work is done in Douglas' 14 stations. There is no paint booth on the line, and camouflaging is not done until the ship is completed.

A new feature of the work stands beneath these lines is inclusion of indirect or reflected light. Floor areas of the lines are painted white and kept clean. Fluorescent lights hang low below the assemblies with reflectors in the normal position so light is thrown down to the white floor. In what would otherwise be dark working areas, shadowless, even illumination "just like daylight" is the result. Workmen

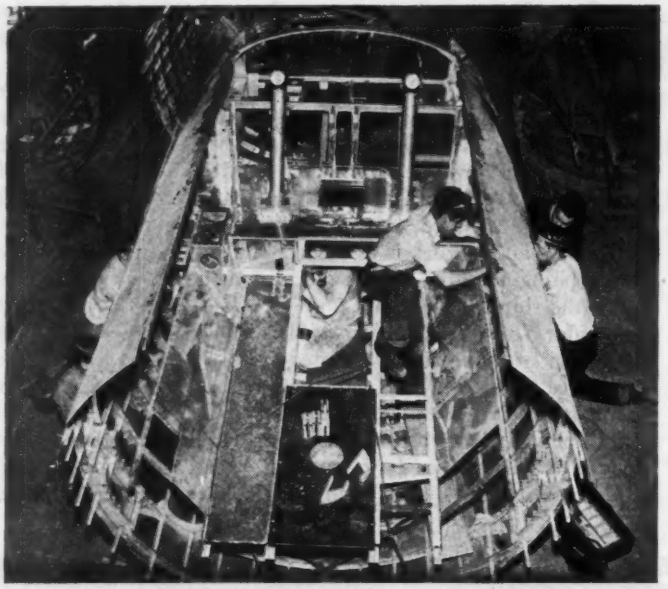
Inner wing sections removed from vertical master jigs are placed on handling fixture equipped with hydraulic lifts to raise for attachment to overhead carrier.



Seen here is port inner wing line, beginning at rear and progressing to engine installation in foreground. Overpass at far right is for pony truck transportation to serve storage racks to be installed on balcony.



Structural component breakdown and pre-assembly of parts make units like this pilot's compartment take shape rapidly, after critical points are first established in jig. Control columns are only identifying parts shown in place.



Skin sections being riveted on same structure.

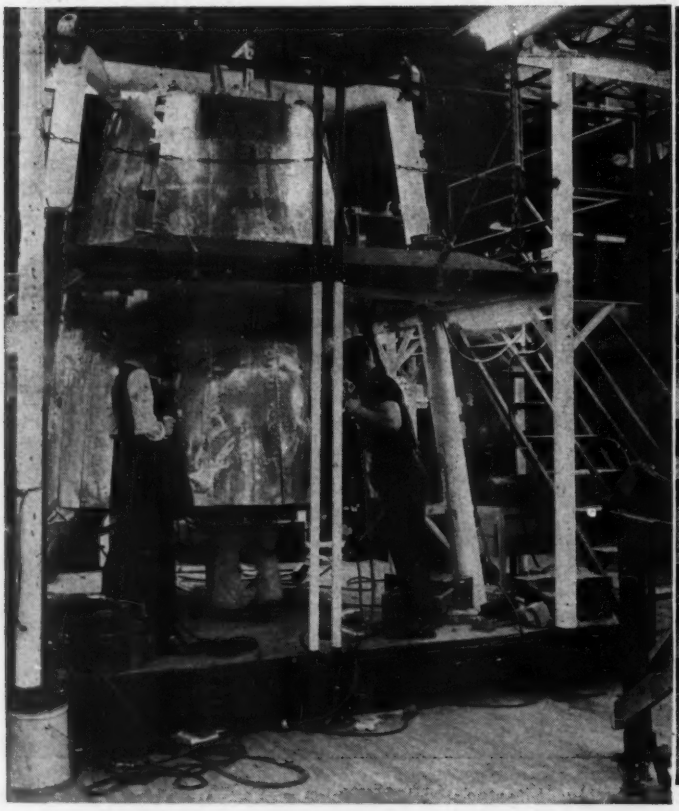
say they like it, and their production indicates that is true.

An example of pre-assembled component breakdown is best shown in the photos herewith which specifically depict the assembly of pilot's floor, sidewalls, and No. 3 bulkhead being riveted together, with the only thing in sight identifying the section as part of an airplane being the two control columns already in place. To this structure are later added pre-assembled skin sections, seen awaiting use in nearby storage. All lines where these operations are performed are located on a balcony from which the assembled section will be lowered to the main floor, where it will be joined to other fuselage sections.

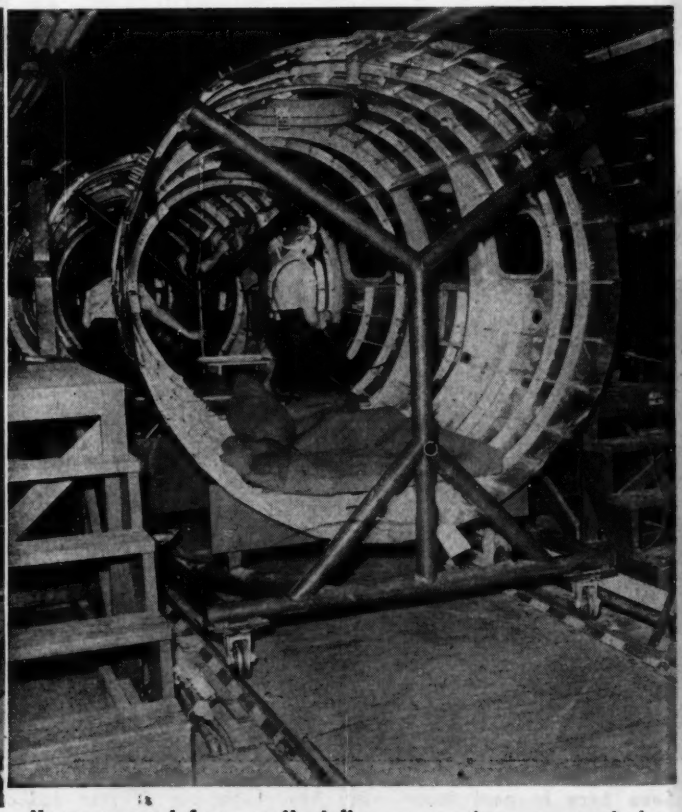
In assembling pre-assembled skin panels, the circumferential stiffeners, stringers, and skin are riveted together very rapidly on an Erco One-Shot riveting machine, which we rebuilt so large panels could be worked in it. Clecoed together in jigs before reaching the Erco unit, the panels are attached to a counter-weighted holding fixture so a girl operator can move them are-wise over a higher-than-usual mandrel post.

The fuselage nose section, made up of four pre-assembled skin panels—two sides, top and bottom—are tied together in a hydraulically controlled vertical jig we call the "tepee" because of its Indian tepee shape. A 10-ft. high jig, this "tepee" has two levels, where work goes on both inside and outside simultaneously. After removal from this jig, the nose section is mounted on a carrier that runs on angle iron inverted V rails through four pick-up and four installation stations. With places for workers both inside and on stands of varying levels outside, the section moves quickly through the line and is ready for lowering to the main floor when it emerges from the eighth station.

Similarly, the radio operator's compartment is assembled (station 5-6) from pre-assembled skin sections, the work

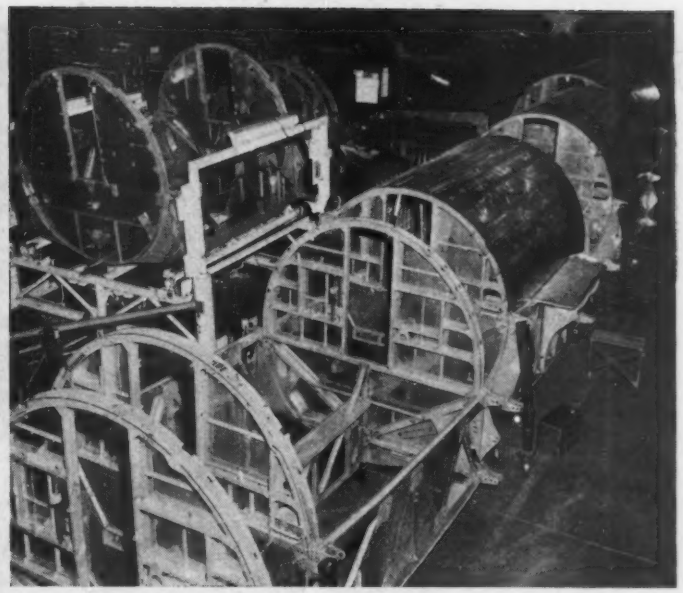


Pre-assembled nose panels are joined in "tepee" jig, built at Vega, which affords two working levels.



Upon removal from vertical jig, nose sections are attached to carrier which moves on rails through four pick-up and four installation stations. Work progresses both outside and inside.

Central radio compartment is assembled from prepared structures in a vertical jig. Critical points are established at stationary base and by movable top frame on tram hoist which is used to remove assembly from jig.



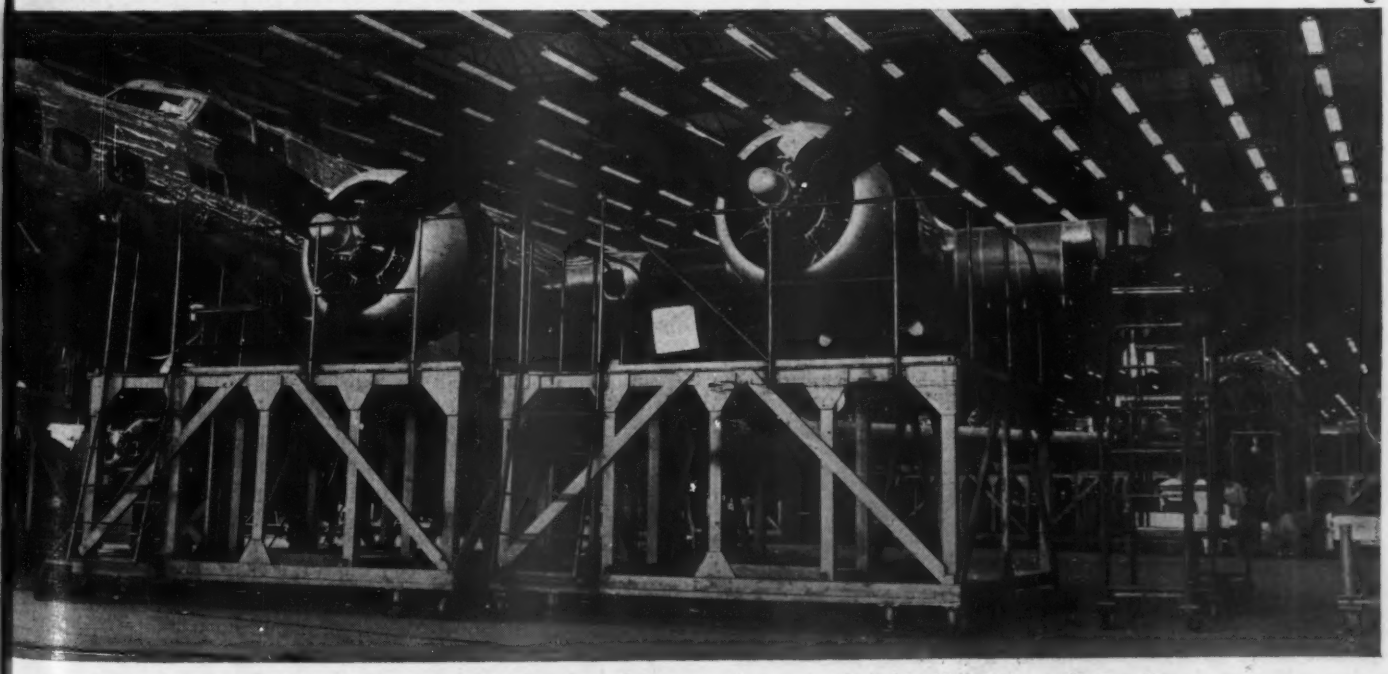
Center section is started in stationary jig at left, is then transferred to line carrier, where joining and skin riveting is completed. At the end of this line unit will be ready for union with other sections in master jig.

being done in a vertical jig of Vega design. Critical points are established in the base and through a frame in the upward end, which is attached to an overhead tram with an electric crane motor rigged so that women may readily load and unload it. After removal from the jig, the section is transferred to a wooden platform where pick-up and installation work is completed.

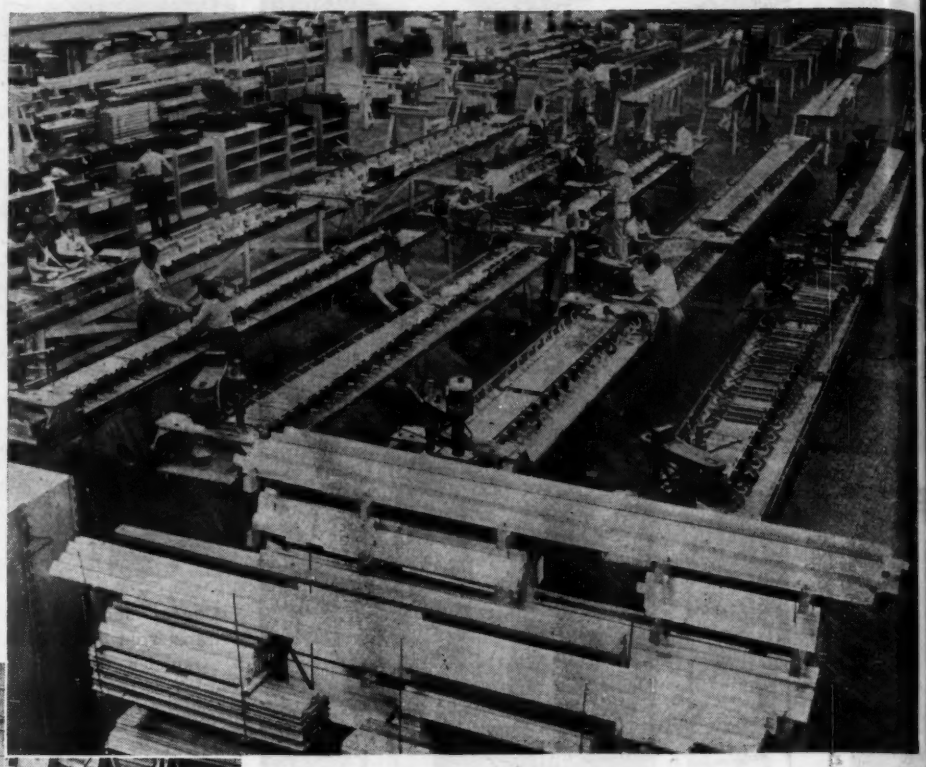
In several balcony pre-assembly departments, overhead storage of parts in racks suspended from roof supports makes possible full utilization of building space and more compact arrangement of the floor equipment. Overhead racks provide stock storage which in many instances is closer to point-of-use than would be possible with floor level racks.

The aft fuselage sections, like other sections of this air-

(*Turn to page* 318)

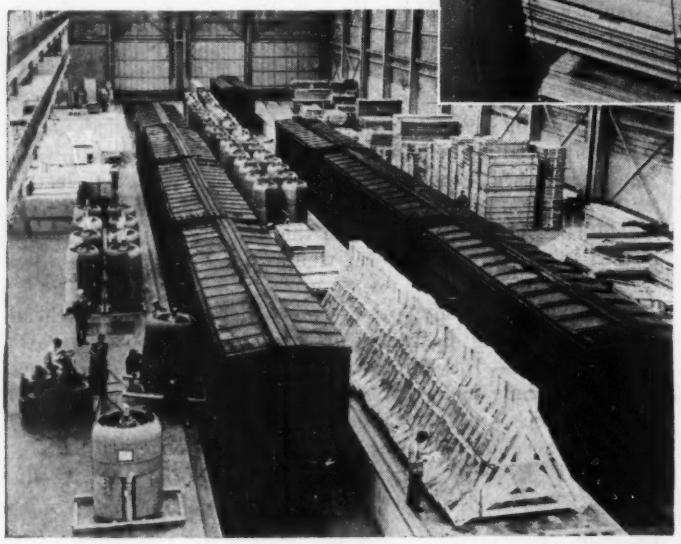


In first of three final assembly stations, outer wing panels are attached. After inspection and correction of "squawks" plane goes out door complete, except for paint, which is applied in another building.



Wherever possible in the 117-acre plant, layout provides that work moves directly from one operation to another adjacent, as shown in these spar operations. Here, for example, stock bins of finished aluminum are set up close to work to eliminate "dead time"—that required for material to reach one operation from another. Note stands in background, easily movable to provide fluidity of fabrication.

Power plants, propellers, and raw stock reach Consolidated Vultee's Fort Worth plant to become components of either B-24 *Liberator* bombers or C-87 *Liberator Express* cargo planes. Both subassemblies and raw stock will move immediately to storage near their stations on final assembly or in processing departments. One more railroad track and large truck docks are contained within building.



"Liberators" by Consolidated Vultee

By GEORGE S. NEWMAN

Manager, Fort Worth Div., Consolidated Vultee Aircraft Corp.

Controlled, fluid, production planning is essential to meet high production schedules for cargo-transports as well as *Liberator* bombers required by both AAF and British Coastal Command.

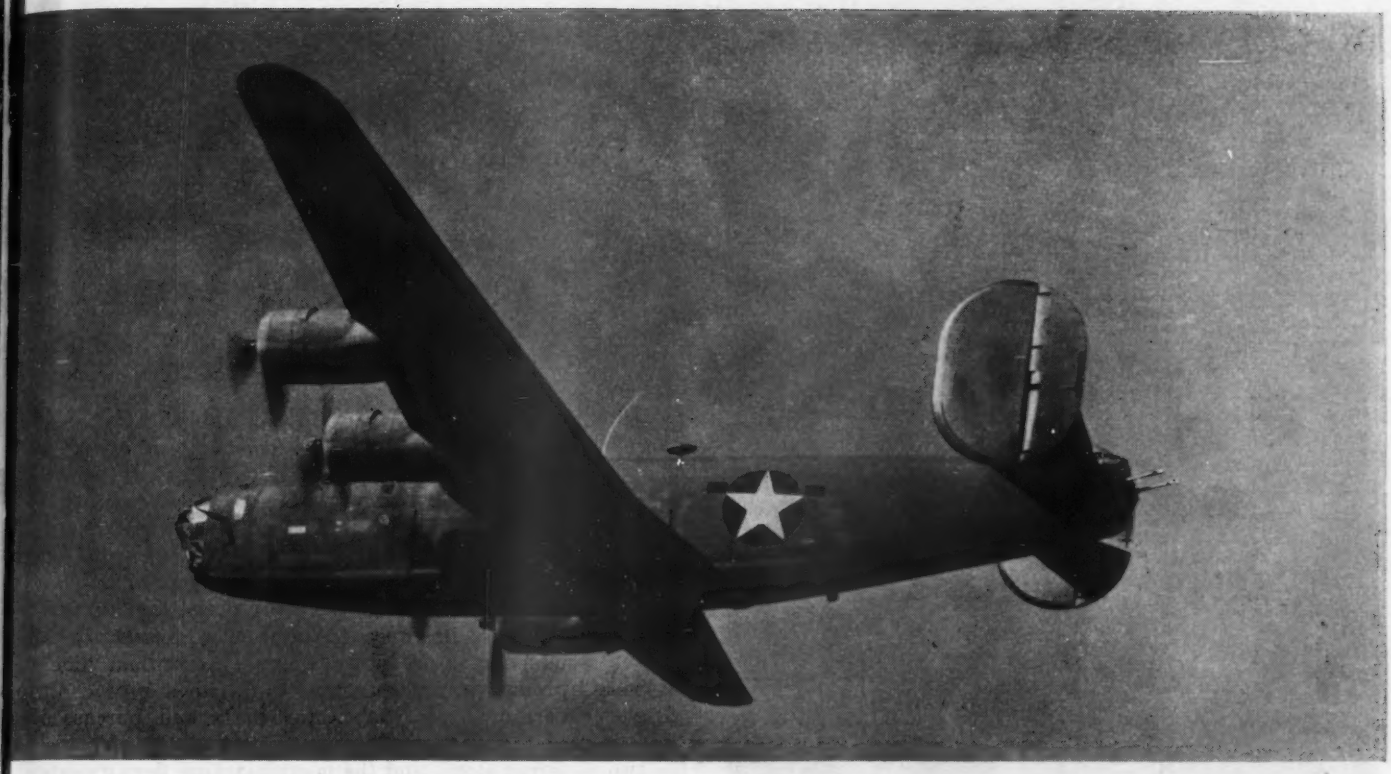
To lower production hours, each part is as nearly complete as possible before leaving its department. Here stringer and bulkhead subassemblies are built up in fixtures prior to installation in wing center sections, a system contributing to greater over-all production.

NOT SO MANY YEARS AGO, before war brought the need for thousands of airplanes every month, a factory manager could give worker Joe Doakes a few parts and tell him to see that they got on a certain ship—perhaps the only plane in the plant. And Joe would see that the parts were put on the plane.

But current demand for more aircraft in a month than the entire industry formerly produced in a decade has wiped out the personal touch in airplane building.

Today, emphasis is on mass production—which means controlled material flow and proper planning of assembly operations. Briefly, mass production is the timing of the flow of materials and parts so that a worker gets a specific piece at the split second he needs it for his particular operation. But this function doesn't stop with one worker—it is carried through the entire plant. The timing must be perfected from station to station.

The Army Air Forces ordered immediate conversion of a number of B-24 components to transports in order to speed



important men and material to the fighting fronts. Our first C-87 left the plant late in the summer—more than 30 days ahead of schedule—and carried Wendell Willkie on his epic globe-girdling flight.

Most aircraft plants, like Topsy, have "just growed," spreading out as additions were needed to meet a rapidly expanding war program. Several years ago, however, Consolidated Vultee, drawing on its 20 years of experience in construction of large aircraft, drew up plans for a completely new type of plant based on efficiency alone. Result is the Fort Worth plant, built by The Austin Co. as the largest windowless factory and probably the largest self-contained aircraft manufacturing plant in the world.

Because of this very size, though, one of the most important layout factors considered was the distance a part must travel while not in work. The time required for material or a part to reach one operation from another we call "dead time." The plant's 117 acres of concrete working space have thus been laid out to provide a minimum of material travel and, consequently, a maximum labor output going into the finished product through substitution of working for travel space. Wherever possible, workers' benches are so arranged that parts may be handed from one to another.

This type of planning has made it possible to keep the plant's two assembly lines continuously moving, producing not only B-24 *Liberator* bombers, but C-87 *Liberator Express* cargo planes. In addition, part of one of the lines has inaugurated assembly line modification of B-24's.

When the plant was first occupied in Mar. 1942, there was no parts building; that was destined to come later. There was, however, one order: "Get into production."

Little more than a month later, utilizing parts and subassemblies from our San Diego plant to test the planning and feasibility of the assembly line, the first B-24 was rolled from the building and flown—more than 100 days ahead of schedule. It was soon apparent that our Fort Worth assembly could readily outstrip its originally intended function, which was assembly of bombers from parts to be supplied by a plant located at considerable distance in a northern state. So a parts manufacturing building was ordered.

Meanwhile, however, parts machinery began to arrive, to be set up and put in operation in a section of the assembly building so that production could begin and the all-important job of training thousands of workers could get under way for this new job.

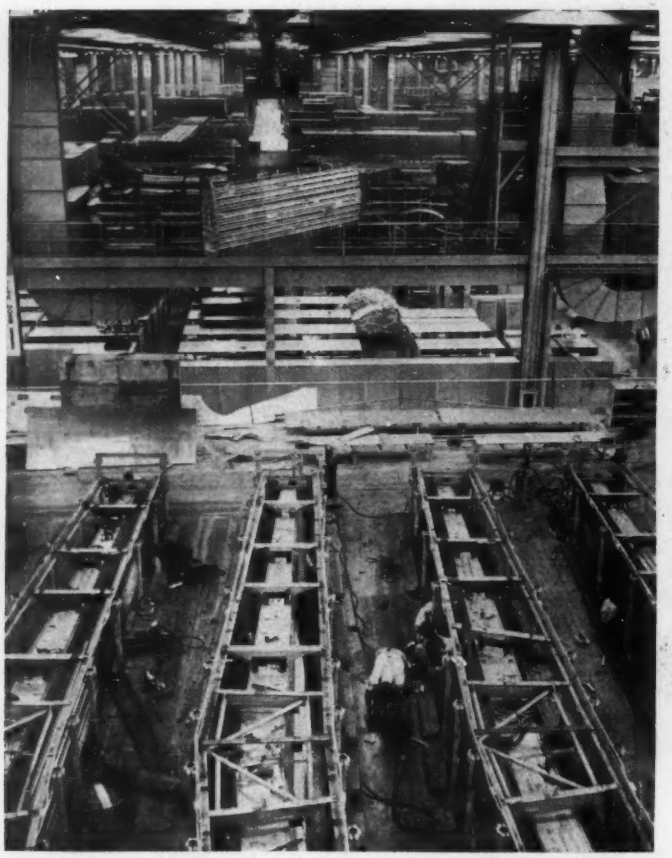
By the year's end, long assembly lines were ready for continuous motion, instead of the intermittent operating method often employed. Fifteen days after the start of 1943, the majority of the parts machinery was moved into the new parts plant, and through pre-arranged scheduling not a day was lost in the use of machinery.

Material flow has, in many instances, decidedly reduced the distance a piece of aluminum travels from initial raw stock to final part of a finished B-24—reduced the distance from 10 or 12 mi., the "travel" in some plants, to less than 1 mi., all despite the enormity of the Fort Worth plant.

Basically the flow of material is this: Raw stock enters one end of the building and goes out the other as part of a completed aircraft. This procedure, of course, is often broken down into several operations, so that the raw stock may be temporarily stored adjacent to its particular department, then flow across the plant through processing into finished parts stock—adjacent to its assembly station—then into the growing aircraft moving along the assembly lines. Other units, such as A & N stores, or government furnished equipment, move into separate storage areas near one end of the parts plant.

As aluminum sheet, for example, is received by the parts plant on one of three depressed railroad tracks reaching far into the building, it is distributed along the raw stock storage area directly behind fabricating departments for which it is destined, such as sheet metal, draw bench, tube bending, welding, and machine shop. Then, after unerating and inspection, it is stored in racks near cutting machines of these departments.

Flow of material through a department such as sheet metal and drop hammer is broken into a number of different paths. Nearly all aluminum first travels to shears. Then it may go to a skin-contour-forming stretch press that reduces the old operating time from 30 to 40 min. to a



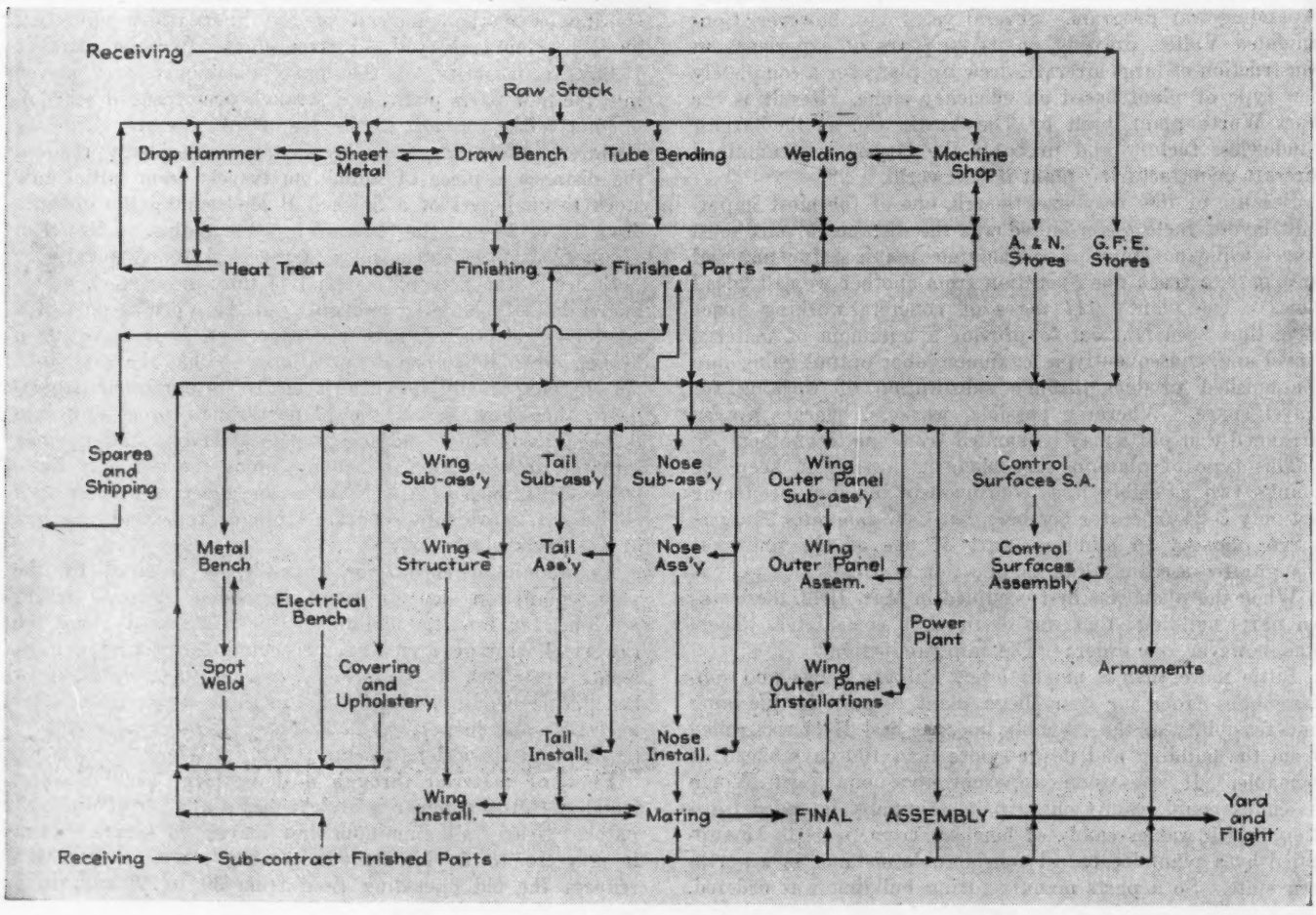
General flow of subassemblies is cross-plant as they grow in size, always as complete as possible before each move. Above, stringer and bulkhead subassembly is moved by overhead monorail crane to take its position in wing buck. Bucks can be seen in foreground.

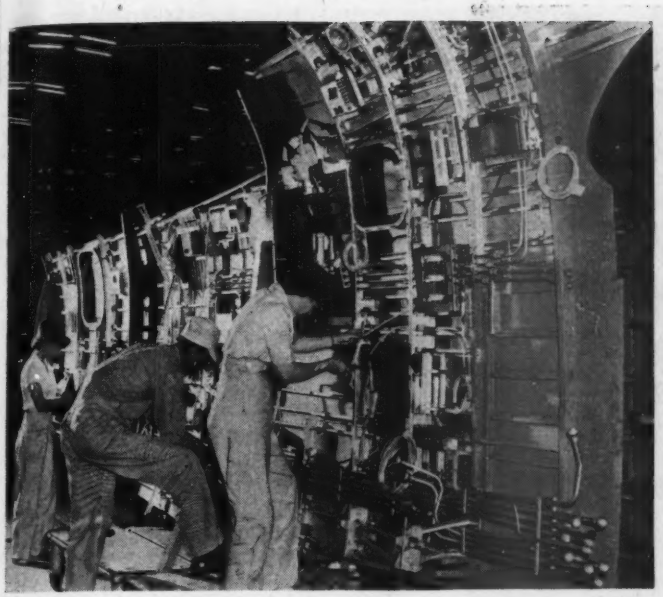
"Liberators" by Consolidated Vultee

flat 60 sec. Some material moves from shears to blanking, punch, or roll presses or to drop hammer. Flowing in many different channels, these parts are processed through drilling centers, burring centers, brakes, etc.—all eventually winding up, of course, in the inspection area. Occasionally sheet metal will be processed through other fabrication departments, frequently to return for an operation.

Because of the countless thousands of parts required and the great variation in processing, the flow necessarily is by "lot" production to production centers, rather than "line" or "mass" production from machine to machine.

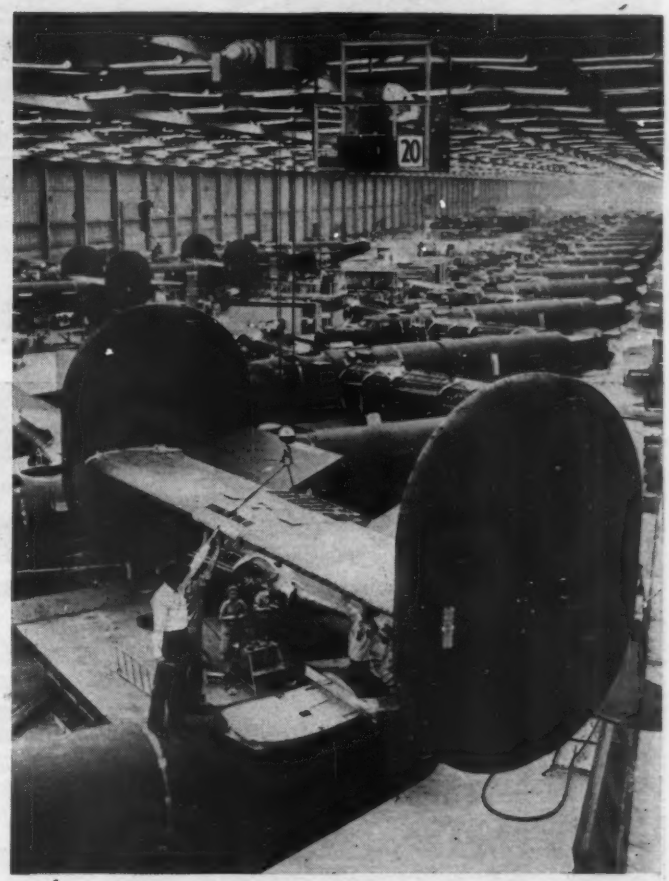
Since a combination of fabricated parts and purchased parts is used to make up the greater part of the airplane, the two receiving stores and the manufacturing departments are located together as a production aid. Fundamentally, these store rooms are centralized control stations from which parts are dispatched to stock racks at the assembly line stations throughout minor and major subassembly departments. Some of the parts move from finished parts stores directly to the spares department, where they are





Extensive wiring and tubing installations are made in final stages of nose fuselage subassembly. Similar operations are performed simultaneously on opposite fuselage side, top and bottom, the various units then being mated in special fixture.

Subassemblies, completed in their own departments near proper station on final assembly, are moved as units—such as this empennage—and put in position without interrupting flow of continuously moving final assembly line.



boxed and shipped out to various Army maintenance depots in the war zones.

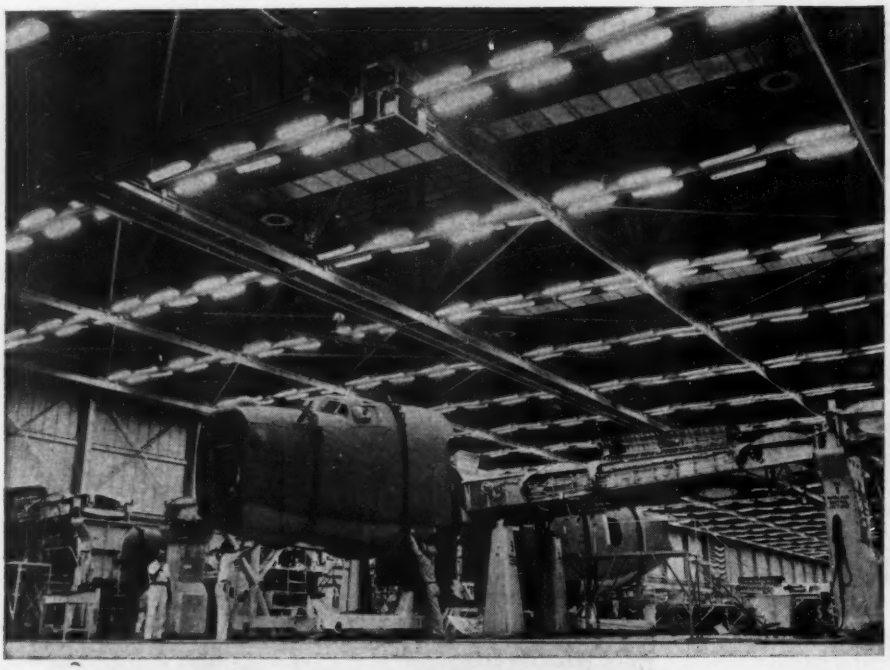
Parts flowing to minor assemblies are stored in racks along aisles in the departments in which they are to be used. Bulkheads, belt frames, bomb bay side panels—all move to specific areas. Fixed equipment in the B-24 is made up in metal bench; electrical harness in electrical bench; upholstery and covering in the upholstery department. Some minor subassemblies are built primarily as bench work on the mezzanines, later to be incorporated into major subassemblies, while others move directly into installation points along the assembly lines.

Major assemblies, such as wing center sections, nose and tail fuselages, wing outer panels, and control surfaces are assembled from thousands of small detail parts in larger steel fixtures. The fixtures remain stationary and workers move from jig to jig. The procedure is reversed on the continuously moving assembly line, where the movement from "lot" to "mass" production finds the major assemblies moving and the workers and materials in fixed positions.

To cut production hours, each part is made as nearly com-

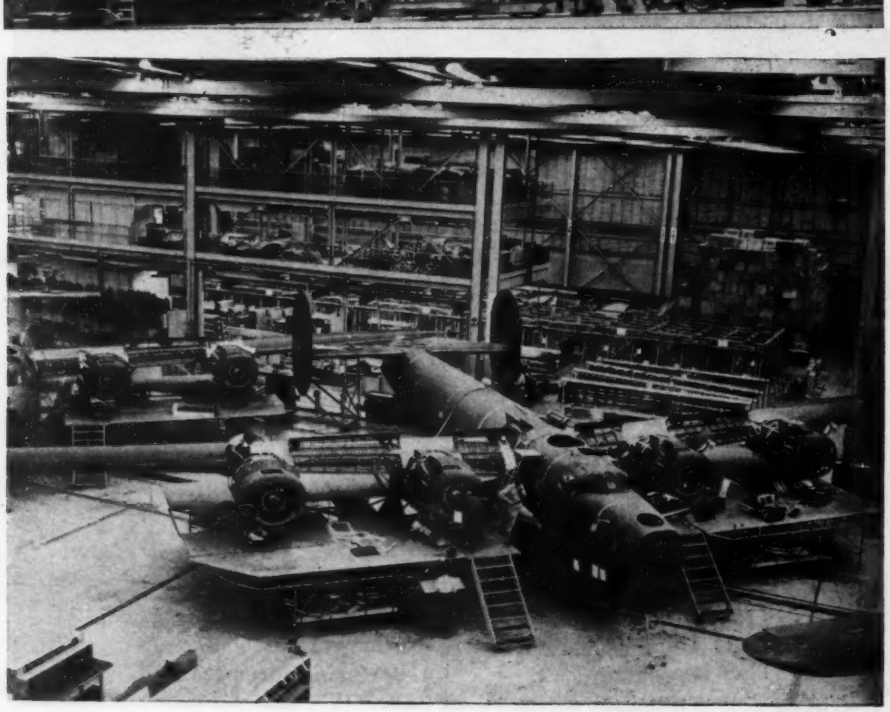
B-24 bomb bay installation fixture at Consolidated Vultee Fort Worth plant. Center wing section rests on four positioning points shown atop pedestals seen at left and right. Bomb bay panels are held securely in place by "T"-shaped stretcher bar just behind legs of two men workers in foreground.

"Liberators" by Consolidated Vultee



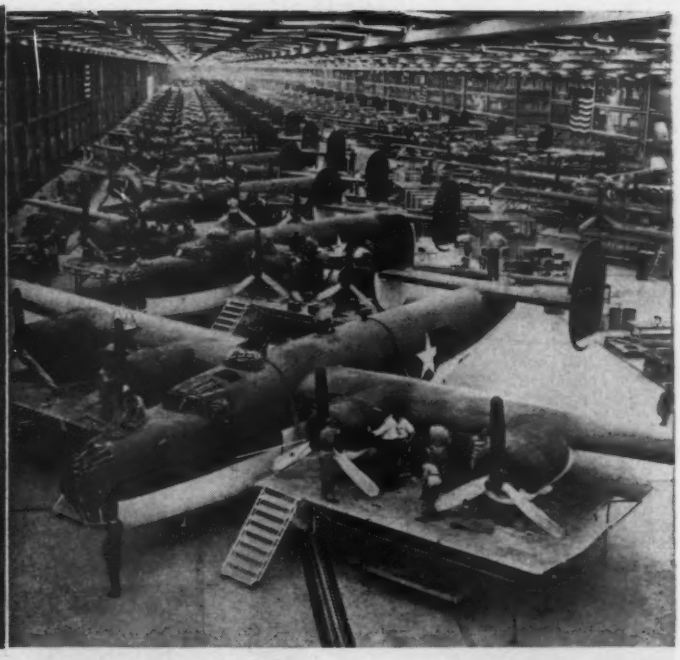
Fuselage nose is lowered into car which is integral part of mating fixture. Car will move nose section back into position with center section, seen resting on pedestals. Aft fuselage section, resting in similar car and also held in position by steel straps, is similarly ready for mating with center section.

Coming from mating fixture, fast-growing *Liberator* is placed in carriage for trip along continuously moving final assembly line.



Proximity of material storage to working stations at Consolidated Vultee Fort Worth plant is clearly shown here. Note use of two levels of balconies to give added stocking space. *Liberator* bombers move along final assembly line at 45-deg. angle, giving closer nesting, which means three planes can be put in space of two, end-to-end.

Bombardier's enclosure installation is one of last operations of final assembly, to permit easy movement of personnel through plane. Note large platforms comprising part of carriage, complete with detachable table for foremen's reports and parts bin. These are seen just to left of castered ladder.



Partial view of world's longest double mechanized aircraft assembly lines at Consolidated Vultee's Fort Worth, Tex., plant. Production line at right is exclusively for B-24 *Liberator* bombers, fore part of line at left is modification line, while that to rear is for assembly of C-37 *Liberator Express* cargo planes.

plete as possible before the major assembly leaves its department. Such time-saving is especially noticeable in the nose fuselage operations, where a much greater percentage of wiring and other intricate interior installations, formerly done in final assembly, now are completed in the primary assembly.

Further innovations crop up in the wing bucks, where skin and stringer panel fixtures have supplemented the original jigs in an ever-improving tooling program. Complete stringer and bulkhead assemblies made up in subassembly fixtures are dropped into the wing fixture.

These mating jigs, unlike the spider-like arrangement common to such fixtures, tend to give more rigidity as well as to leave more unimpaired working space about the wing and fuselage areas.

Just as the moving horizontal conveyor line has eliminated the necessity of transporting the wing center section to the mating fixture, the proximity of nose and tail assembly departments to the jig eliminates much travel and handling. The overhead cranes quickly and smoothly drop nose and tail fuselages into fixed positions in the jig, where these assemblies are held by straps. All chances of variation are eliminated.

With mating of the nose fuselage, center section, and aft fuselage completed, the overhead crane lifts the mated craft from the fixture and places it on a carriage for its trip down one of the long assembly lines. The 28-ton planes move down these lines at 45-deg. angles, thus allowing the noses and tails to nest together, thereby gaining space for one extra ship out of every three put on the line. Experience with the big craft

(*Turn to page* 321)

Inflation of landing gear oleo shock struts lifts B-24 onto its own wheels for first time, raising it from carriage in which it was cradled through many stages of final assembly and readying it for engine run-in and test flight.

Willow Run's final assembly bay is 150 ft. wide, 36 ft. high. *Liberator* bombers move nose first on their own landing gears.

"Liberators" by Ford

By CHESTER S. RICKER

Analyzing the fabrication and assembly methods employed at the much-discussed Willow Run plant, which is now held to be hitting production stride.

WILLOW RUN is more than a plant for building *Liberator* bombers. It represents the impact of two great, but different, manufacturing philosophies: The very flexible and easily changed methods common to the aircraft industry, and the rigid and fixed methods used on high unit production where designs can be frozen for a year or more.

Willow Run is, as a result, like a child born under the constellation of Gemini, the "Twins"—trying to do two different things at the same time. Entirely aside from the initial personnel training and transportation problems which naturally delay starting new production, Ford engineers and production men have had to re-orient themselves.

For 20 yr., the key men have thought in terms of tremendous unit production—millions of duplicate parts a year and from one to five cars a minute coming off the production line. The reconciliation of two widely divergent manufacturing viewpoints has been a tremendous problem for both Consolidated, who conceived this child, and Ford, who has fathered it. Under the stress of combat experience, the former has been forced, in womanlike fashion, to constantly change her mind about what was required and the latter, in fatherly fashion, has tried to satisfy every whim.

Getting production started under these circumstances has been the task of both Charles E. Sorensen and Logan Miller, who have been the guiding hands in getting Willow Run launched.

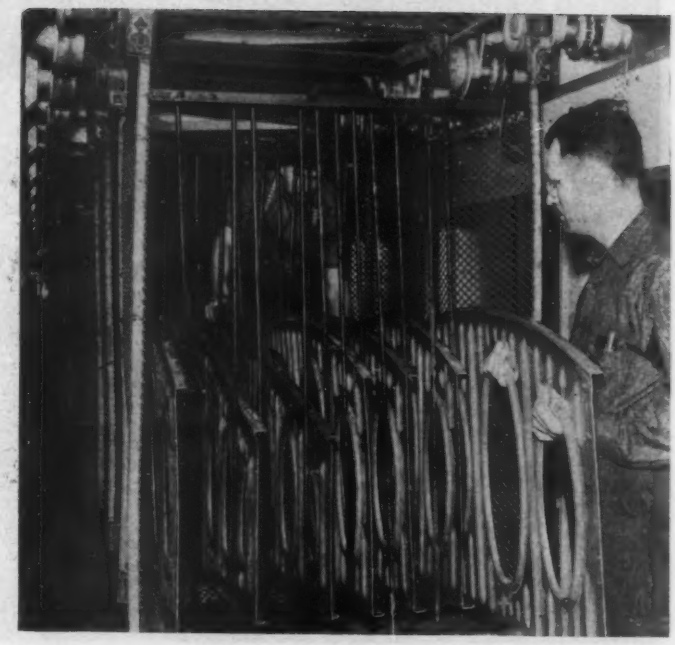
The difference in what has been done here and at other automotive plants converted to aircraft production can be summed up very quickly. Ford introduced manufacturing methods which were conceived out of 30 yr. experience in building auto chassis and bodies. Almost all other automotive air frame subcontractors took aircraft methods and applied to them as much automotive knowledge as they could. Now that Willow Run is producing, the entire manufacturing personnel has turned its attention to methods which will increase output. In one particular case, a complete rearrangement of the spar department and the use of new tools has increased production nearly 20 times with the same number of employees.

Willow Run is just getting out of swaddling clothes, but growing fast. It should reach full manhood before the year has passed.

In such a huge plant, where the assembly line distance from first wing parts assemblies to the airport doors is almost a mile, where the machine department is a good quarter mile long, and where the ship assembly bays are a clear 150 ft. in width and at least 36 ft. high, one would need to write an entire treatise on aircraft production methods in order to tell all the interesting details.

Therefore, only the principles followed in plant layout, the

Continuous conveyor type furnace was developed to handle necessary volume of heat treat work. Here workers load carrier which, rolling on overhead track, moves parts to be heat treated through furnace to quenching spray at other end. Rods, shown here as vertical separators, can also be set in horizontally to serve as shelves for smaller parts.



special fabrication processes, the unique Ford mixtures, and the method of coordination of these subassemblies on the final line will be given detailed consideration.

Willow Run may be divided into three distinct manufacturing units: One in which raw material is converted into finished parts suitable for subassemblies; a second where the fabricated units are put together in subassemblies; and last, the combination of subassemblies into the complete product. The latter is the line on which Ford-built bombers are constructed. The first two supply the parts for both Ford ships and "knock-down" parts for other plants assembling similar ships.

The plant area is roughly divided as follows:

Parts manufacturing area	19.0%
Parts subassemblies	18.7
Wing and fuselage assembly	19.2
Ship assembly line	22.9
Inspecting and shipping	8.5
Extra departments (stores, tool room, etc.)	11.7

Note that each of the major divisions represents roughly one-fifth of the total floor area.

In arrangement, the plant follows Ford manufacturing principles: All material comes in at one end and the finished product flows out at the other. This has been modified in only one respect: Government furnished equipment, such as complete engines, propellers, instruments, and armament, are received and kept in separate bonded areas and included in the extra departments mentioned above.

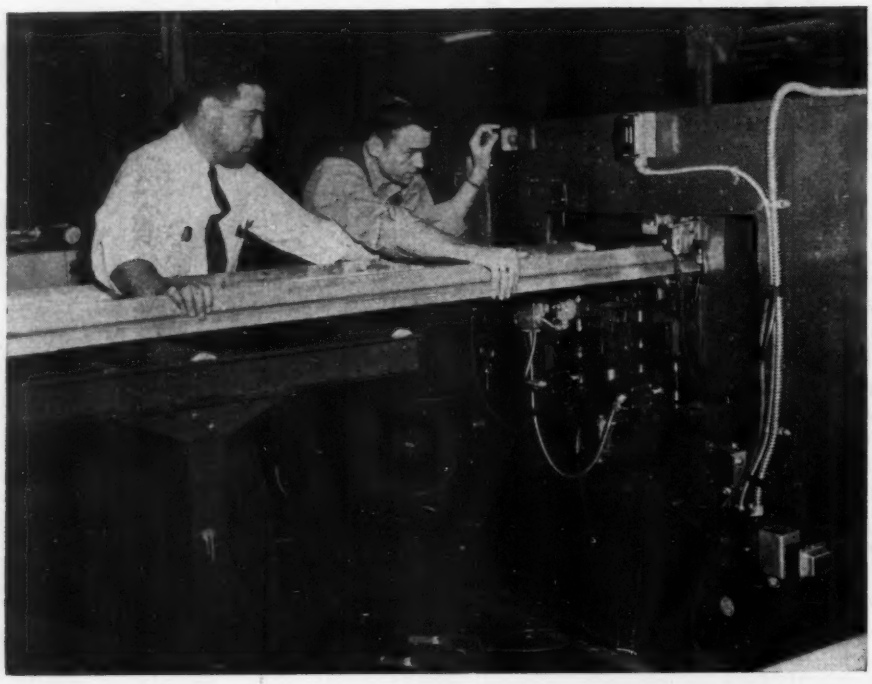
Raw material may be in the form of sheets, coils, wire, forgings, or castings, either finished or unfinished, delivered by truck or rail to a covered section of the plant where it can be unloaded by cranes where necessary.

Receiving inspection is adjacent to the unloading dock; so, also, are the shearing department for sheet metal and the cold heading department for making rivets.

Aluminum wire stock for rivets is inspected as it enters the cold heading department, where millions of rivets are made each day; over 550 different sizes and types are used regularly.

One Ford technique applied to aircraft production is use of Yoder rolling machines to form all angle, hat-section, and other special shaped reinforcements and stringers. Note automatic traveling shear just beyond rolls. This cuts stock to length without stopping flow of strip through forming rollers.

Typical spar drilling fixture in which web and rails are drilled preparatory to riveting. Radial and track support of drills allows them to be used anywhere on spar and assures holes being drilled square with work.

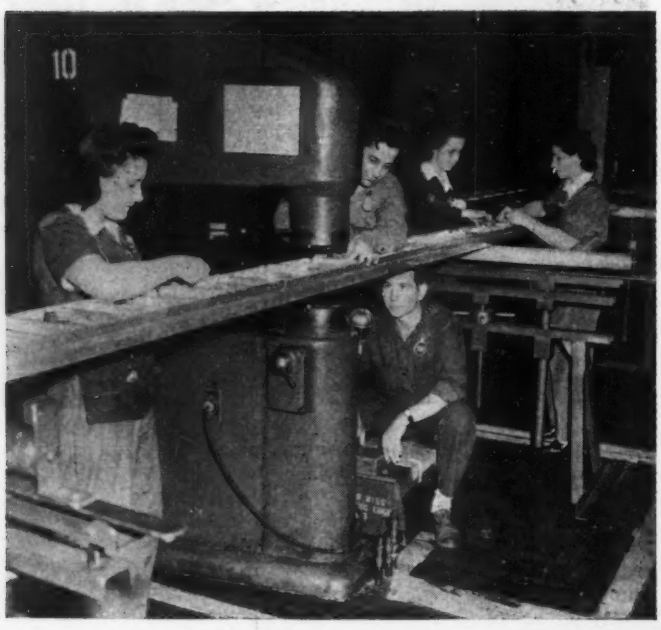


First multiple riveting operation on spars is done on this double-headed machine which rivets angles to plate, with seven to eleven rivets being set up at a time. One head is stationary; other automatically follows taper of spar. Here spar is being started through. Once under way, feed is automatic and operator has but to remove Clecos as work progresses.

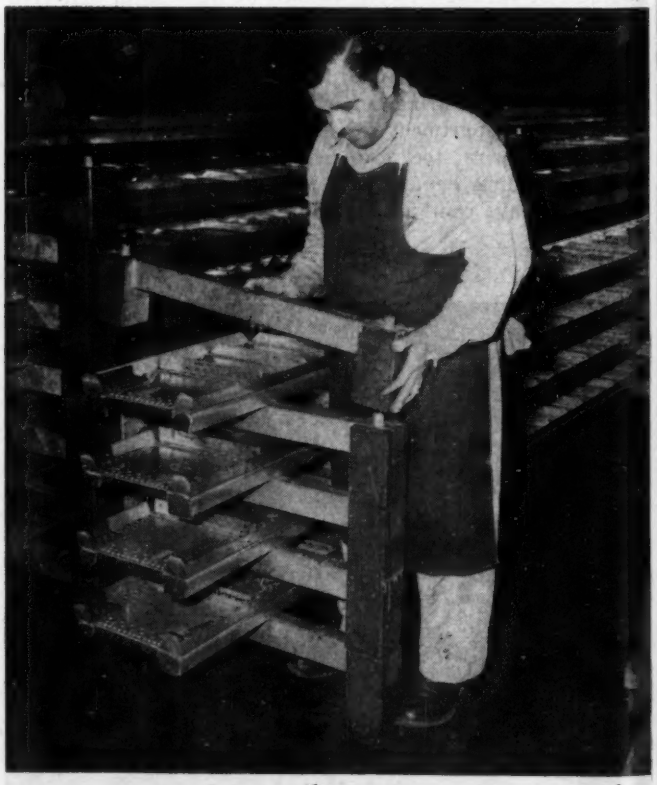
All rivets, except some made from pure aluminum, must be heat treated after cold heading. Those formed from 17S aluminum alloy are degreased, Alroked (which turns them black), and stored until needed. When removed from storage, they are heat-treated and quenched, put in centrifugal dryers, then stored under deep-freeze refrigeration at —20 deg. F. This type constitutes about 20 percent of the 700 lb. of rivets used in each ship. The frozen rivets are packed in cans or cellophane sacks and properly marked, then distributed to other deep-freeze boxes conveniently located along the assembly lines.

Remaining rivets are made of A17S aluminum alloy, and are handled differently. First they are degreased, then heat treated, and finally Alroked. They do not require refrigeration and so can be used at any time.

Handling of sheet metal offers another good example of the Ford technique with materials. The planning and shearing department funnels all stock from the unloading dock to the shears and on to the press department. The work required in handling stock from the raw material to the finished product is reduced to a minimum. For example, practically all sheet stock now arrives on platforms or skids



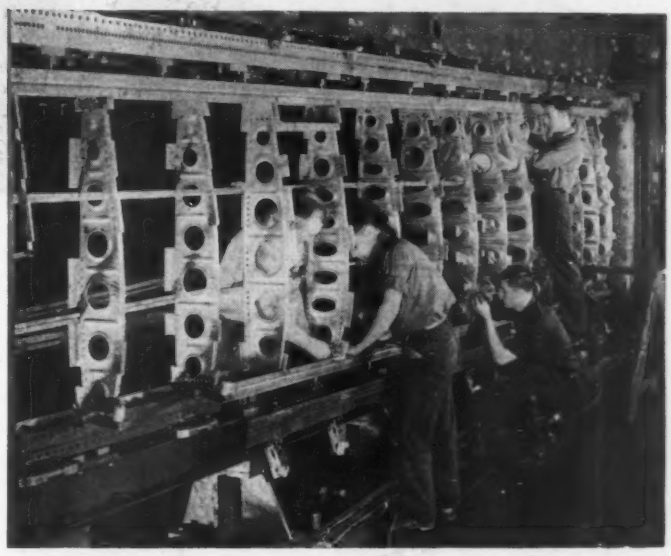
Under Willow Run system, unriveted spars start at one end of line and are ready for assembly on plane at other. Here, women (right) place parts and rivets, operator sits beneath spar to watch upsetting and alignment of squeezer anvils. Note adjustable rollers, which serve dual purpose of conveyors and work bench. In addition to being adjustable vertically, rollers easily slide sidewise permitting fast, effortless alignment of spar with riveting heads.



Last operation on spar assembly line is milling of end, seen in foreground. Finished spars are then carefully handled, being stocked in easily assembled racks shown here.

In outer wing assembly, stringers are first positioned by means of clamps, as shown. Then, with skin clamped in place, punched stringers are used as drill guide. Entire skin is then drilled, holes countersunk and finally riveted. Note elevator platform on which four rivet buckers are working. Platform—with similar one on opposite side—is counter-balanced for easy raising or lowering to give most efficient working level at all times.

Assembling bulkheads between outer wing spars. In this fixture, sides of spars will be drilled for skin rivets, through drill fixture templates hinged in sections at both top and bottom. Template at lower left is raised to drilling position. Overhead beam is mounted on rollers, permitting it to be moved aside for removal of completed wing panel by overhead crane.



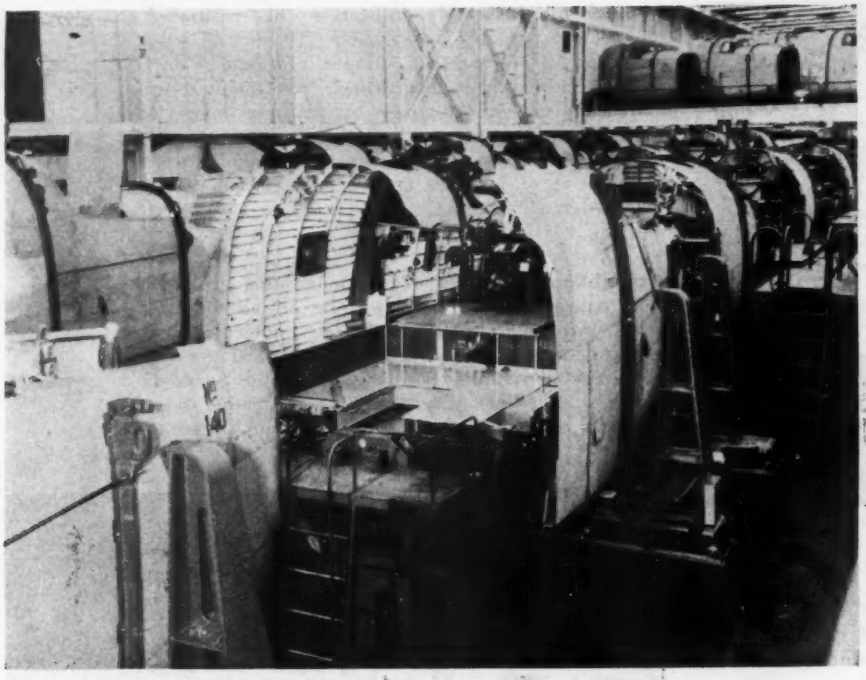
and is slip-sheeted with tissue paper. These skids have side covers fastened with quickly detachable metal bands to protect the stock while in transit. This method eliminates the unpacking of sheets, since they can be removed directly from the stack.

Sheet aluminum formerly came in plywood crates holding but a few sheets. This required hours for uncrating and lots of room, while presenting more chances for scratching, damaging, and wasted material, the salvage value of the crates being negligible. The new method also makes it easier for the producer to pack and ship them.

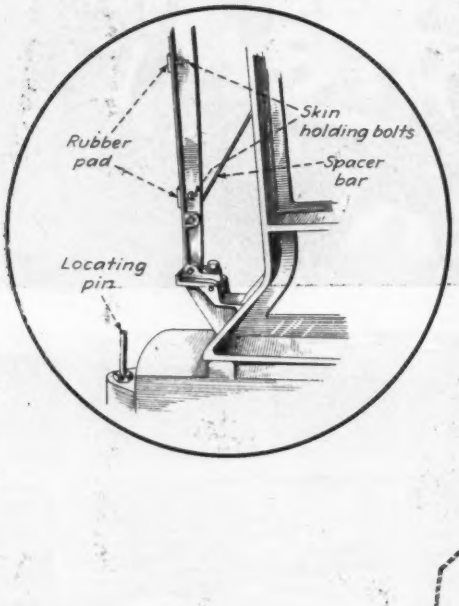
The sheet metal planning department has a carefully worked out schedule which gives the maximum number of pieces and minimum waste from each stock sheet of aluminum. Blanking dies are made so strips may be run through in either direction, and stops are arranged so re-run blanks will be taken from unused portions of the original sheet. In

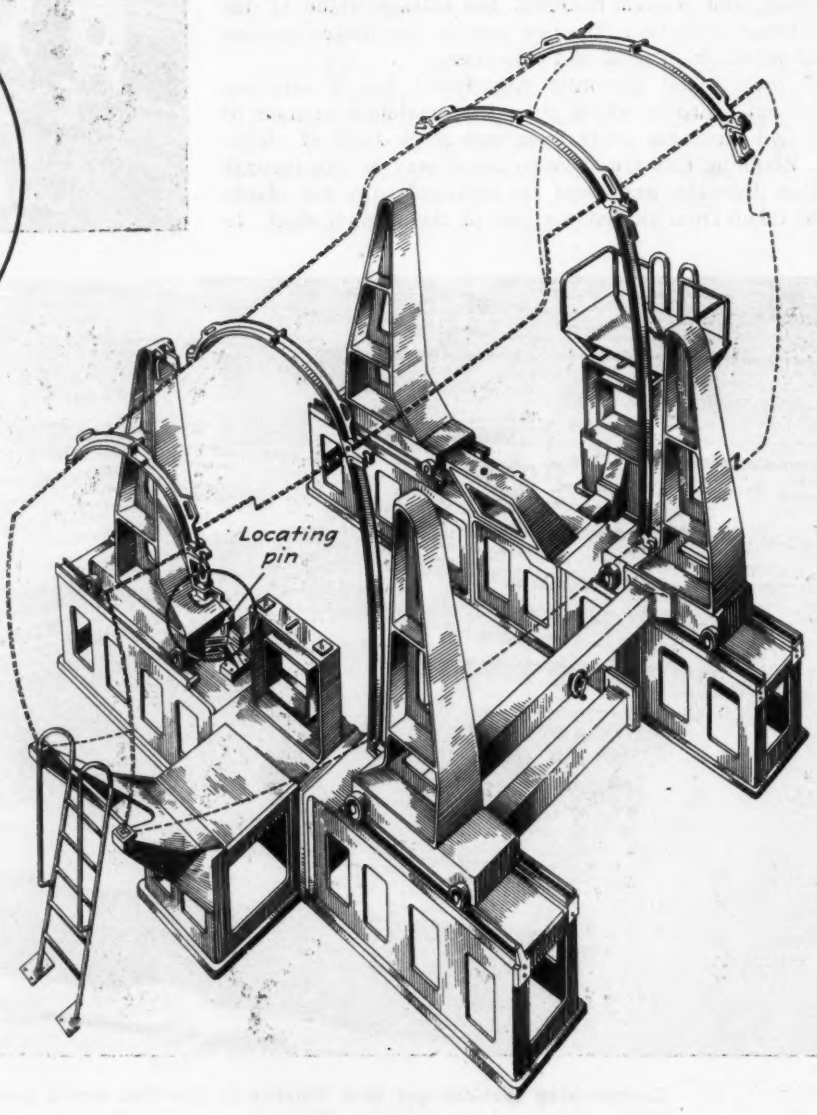
Center wing sections get final touches on this line, moved from station to station attached to two-wheel conveyor plates rolling along track which rises three levels in background.

"Liberators" by Ford

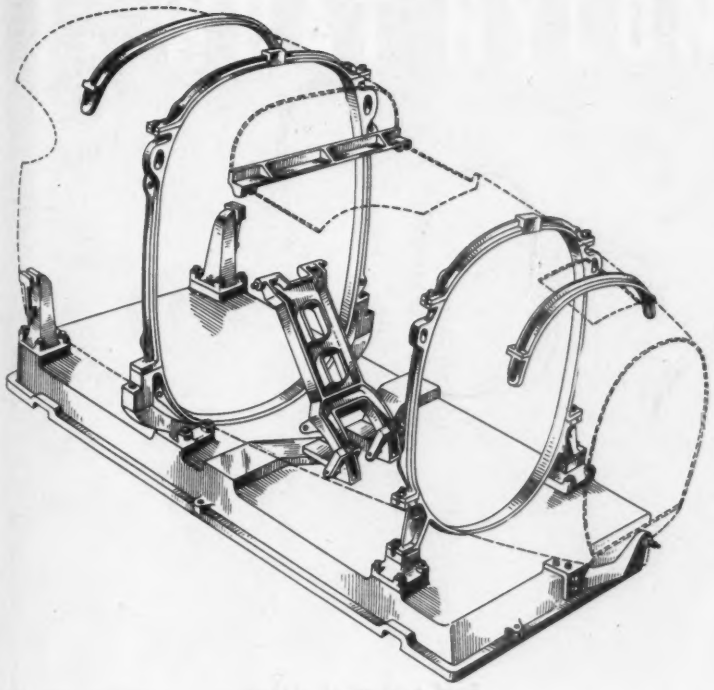


Nose fuselage section is one of the most important subassemblies, with three of its units—pilot's floor and two fuselage sides—being mated in this fixture.

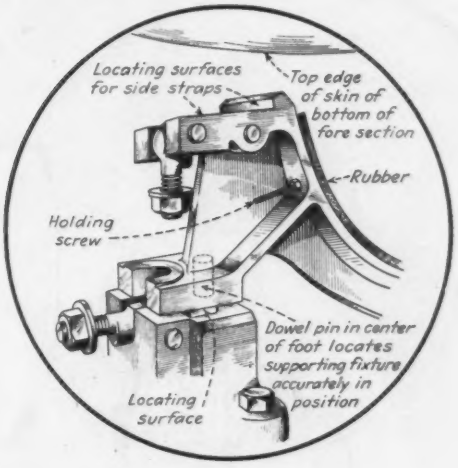




This isometric sketch by the author gives details of nose fuselage mating fixture. Note straps (bolted to fuselage sides) which hold these sections securely in place during mating. Heavy standard holding strap is mounted on rollers so that sides can be moved into position, which is determined by locating pin shown in detail sketch.



This author's isometric sketch reveals details of fixture on which bottom of nose fuselage is held for mating with pilot's floor, sides, and top. Inset sketch gives detail of bottom strap mounting on assembly fixture.


Locating surfaces for side straps
Top edge of skin of bottom of fore section
Rubber
Holding screw
Dowel pin in center of foot locates supporting fixture accurately in position
Locating surface

some cases, scrap loss is less than 10 percent due to this pre-planning with proper shearing instead of squaring of the stock.

Die stocks are adjacent to the shearing and press departments, so each order with dies and stock are drawn by the planning department and routed to the presses. Coil stock is routed by this same department to the slitting machines in the draw-bench section. Here again, by careful pre-planning, the big rolls can be cut with practically no loss of this critical material.

Castings, forgings, and other parts requiring machining move directly to the machine shop from receiving inspection. Throughout the fabricating division, there is no back-flow of parts.

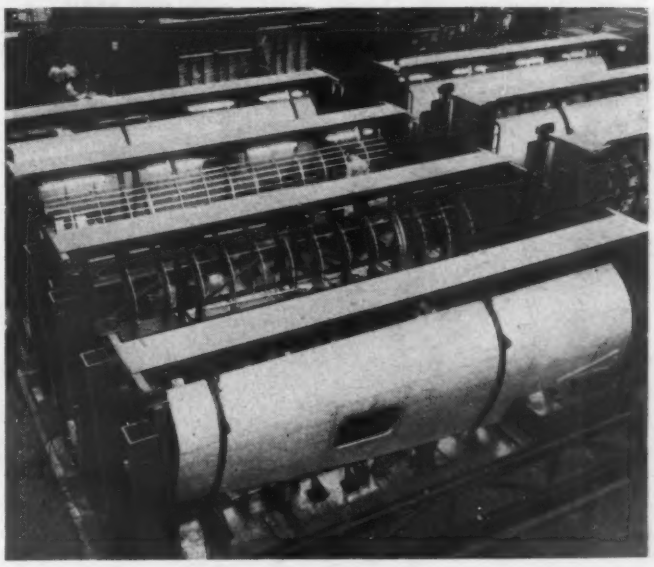
As soon as parts begin to take finished form they are put on an overhead conveyor system almost a mile long, which picks up finished material from the press department and distributes it to the doors and hatches section, cowling, miscellaneous small parts, and nose assembly departments. This conveyor runs the entire length of the fabricating shop—up one side of all departments with stock, returning on the opposite to pick up completed parts, then twice through the paint shop and into subassembly.

The small-parts paint department has its own internal conveyor system, which reduces trucking and crane work and keeps every man on the job in his department. It also reduces to a minimum the amount of material in process.

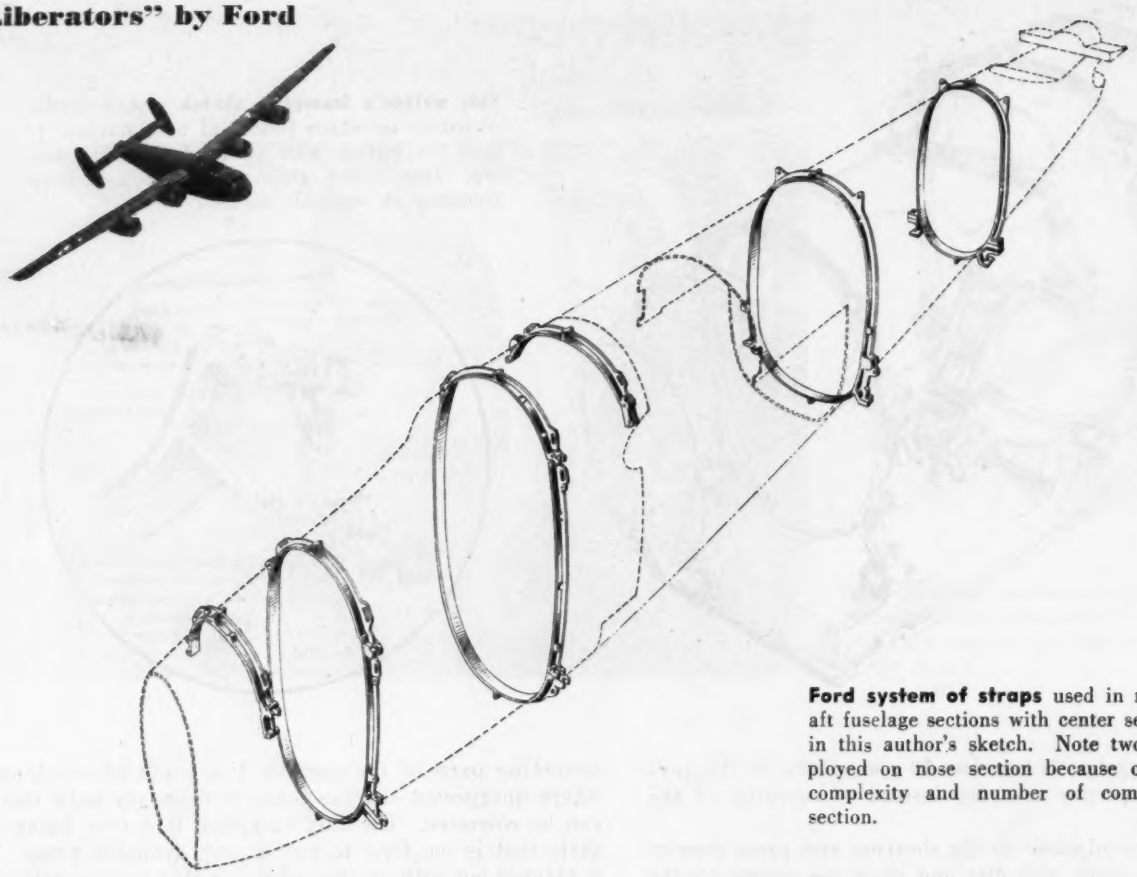
Some of the fabricating department processes are revolutionary in aircraft building, but old in making auto bodies. In forming bulkheads and other intricate parts from ST material, for example, not a single drop hammer or hydropress with rubber draw dies is used. With one exception, all pieces—whether blanked or formed—are fashioned in big presses, single or double acting, most with air cushions. Steel is used on all blanking and piercing dies and on small forming dies. Large draw dies are made of a composition of cast iron to which some steel has been added. Hence, the parts are accurately formed at one stroke. Fitting or reworking parts on the assembly line is not tolerated, except where unexpected changes make it necessary until the dies can be corrected. The only exception is a very heavy spar plate that is too long to put in any available press. This is blanked out with an Onsrud router that runs on rails so as to reach every portion of this piece. A pair of templates are used so one blank can be set up while another is being shaped. The set-ups are on opposite sides of the track carrying the router.

Most press-formed parts are heat treated. Quantities are not so great that dies cannot be held in the press while the parts are heat treated. Then they are re-struck immediately after quenching. With heat treated flat stock the parts are passed through Farnham Rolls for leveling. This department has a huge ice box into which parts are placed to retard air-hardening when they cannot be refabricated at one.

To facilitate handling the amount of material being heat treated, a continuous type furnace equipped with a conveyor system was developed. Suspended from the conveyor are carriers, made from metal lath which has a diamond shaped pattern—carriers which are like big rectangular boxes

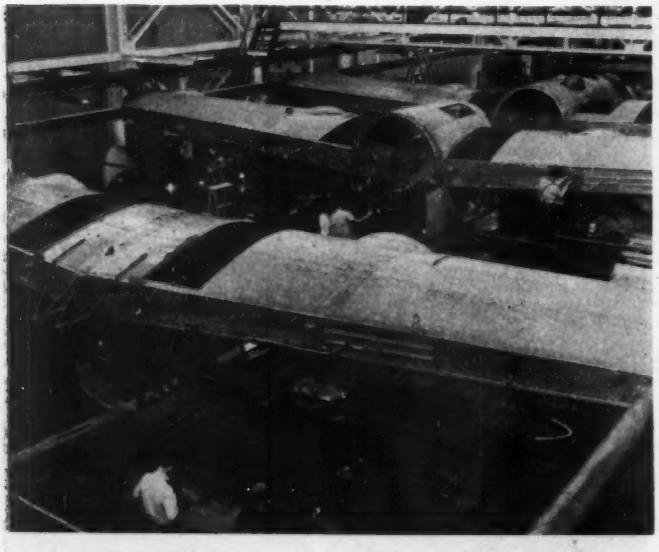


Aft fuselage sides in varying stages of assembly. Same general procedure is followed here as in assembling of outer wing skin. Note how mating straps are applied while side is still in assembly fixture.



Ford system of straps used in mating nose and aft fuselage sections with center section, are shown in this author's sketch. Note two half-straps employed on nose section because of vastly greater complexity and number of components of this section.

without ends. Three-eighths inch iron rods, each with one end bent at right angles to form a handle, are struck through these carriers. The rods can be put in vertically or horizontally to be used as shelving or vertical dividers. Big bulkheads, for example, are put in vertically; small ones are laid in horizontally. At regular intervals one carrier goes into the furnace at one end while another drops out at the other end into the quenching spray. To conserve space, the oven is overhead, each carrier being lifted before it enters the oven, and being dropped down into the quench when it leaves. Parts are inspected before they leave the press department and are then distributed via the continuous overhead conveyor.



Center wing sections start down semi-final assembly line. Bomb bay parts are being installed in fixture in foreground, fuselage side panels at second, and mating with nose fuselage in farthest station.

All stringers and formed shapes are made in the draw-bench department. The name "draw-bench" is really a misnomer here because the metal strip is compressed, instead of drawn out as when stretched through a die in real draw-bench forming. The material is usually reduced in section when drawn but is compressed when rolled. It is claimed that a shorter radius can be used in the corner of an angle when rolling and that thus a more rigid piece is obtained. Furthermore, one set of rolls can be used for several thicknesses of strip stock so long as the angle radius is correct for the heaviest stock rolled. This saves set-up time and number of rolls required. Without stopping the rolls, automatic shears that travel with the stock cut each piece off to the proper length as it is formed.

All rolled parts are made of SO stock and so have to be heat treated. The ovens have two chambers—the farthest one being the treating oven operating at about 925 deg. F. After about one hour treatment, parts are withdrawn into the nearer chamber, where they are given a "shower bath" quench for four seconds.

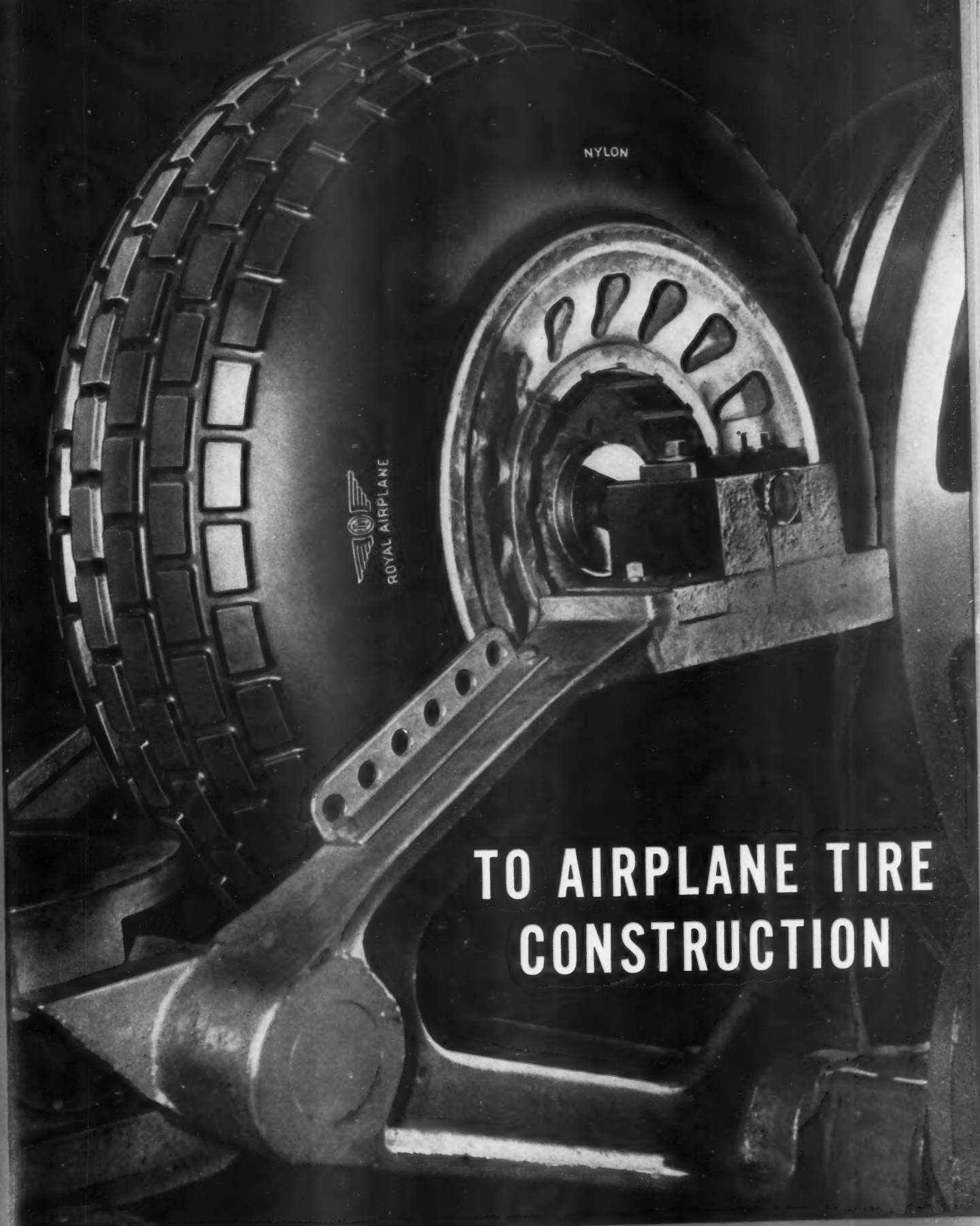
After quenching, the stringers are often twisted, so special Ford-built machines which exert up to 35-tons pull stretch the parts about 3½ percent and thus straighten and set them.

Strippit punches used in Bath bending presses and Cincinnati brakes punch guide holes in stringers and other straight parts. These presses are set up in line and connected so that it is possible to punch accurately stringers that are more than 18 ft. long (the length of the biggest press) since the adjacent press can be operated simultaneously to take care of the extra length.

In assembling bomb bay doors, hand squeezers are used to rivet the roller guide brackets to the ends of the door while the skin is electrically spotwelded to the accordian section of the door. Chemical cleaning of parts to be electrically welded is the procedure throughout the plant, but on these doors a special nickel-silver wire brush scours the surfaces where they are to be spot welded. A special machine, adapt-

(*Turn to page* 161)

WHAT NYLON CAN MEAN...

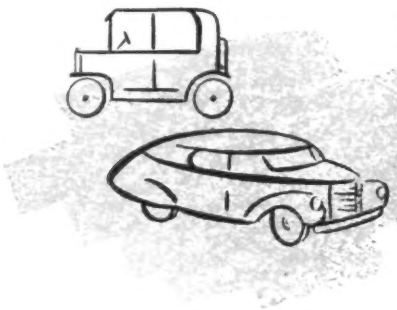


TO AIRPLANE TIRE CONSTRUCTION

UNITED STATES RUBBER COMPANY

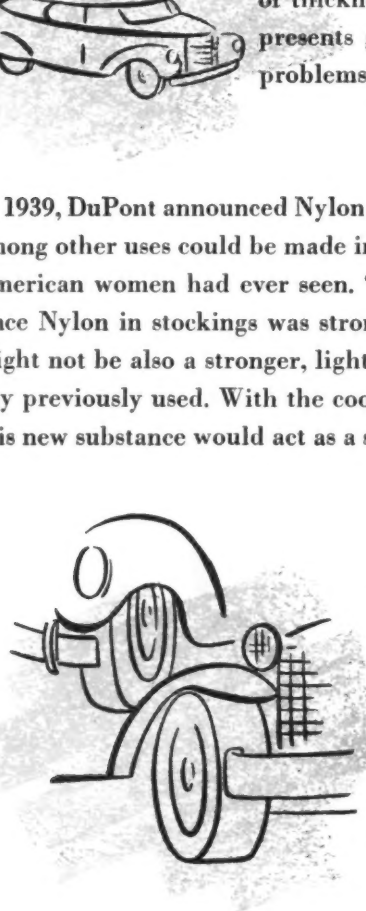
What Nylon Can Mean to

How this stronger, lighter material



Nylon, in some important ways, is as far ahead of cotton or rayon cord for use in airplane tires as fluid drive is ahead of the old-time foot pedal gear shift. One way in which it is superior to either cotton or rayon is its great strength per unit of thickness. In the design and construction of airplane tires, this characteristic presents great possibilities. Yet, there are still unanswered questions, unsolved problems, unexplored horizons.

In 1939, DuPont announced Nylon to the public—a new miracle material, which among other uses could be made into the sheerest, strongest, loveliest stockings American women had ever seen. "U. S." research men wondered – wondered since Nylon in stockings was stronger, sheerer, more resistant to runs, why it might not be also a stronger, lighter, more efficient material for tire cord than any previously used. With the cooperation of DuPont, they set out to see how this new substance would act as a substitute for cotton or rayon tire cords.

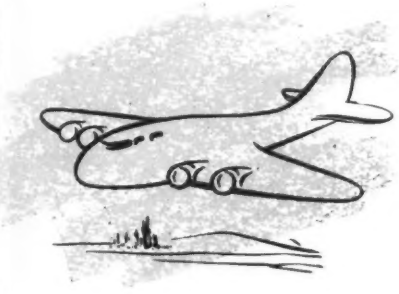


It was natural for "U. S." to undertake this problem because for years "U. S." laboratories had pioneered and developed rayon for tires and "U. S." factories had produced rayon tires for automobiles, trucks and airplanes. With this background of experience in related fields, a practical Nylon construction was soon developed. The earliest laboratory tests indicated possibilities that a superior strength material for use in tire carcasses had been found—that stronger, lighter tires than had ever been known before could be built with Nylon cord.

Then passenger and truck tires were built and tested on dynamometers. Hour after hour, day after day, these tires were run on the giant test wheels without a stop except for a periodic examination. Finally truck tires with Nylon bodies were put into high-speed service over scorching highways. In every test these Nylon-built tires proved that they could outrun and outperform the best tires built of cotton or rayon cord.

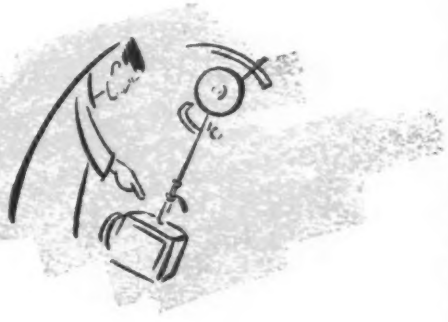
Airplane Tire Construction

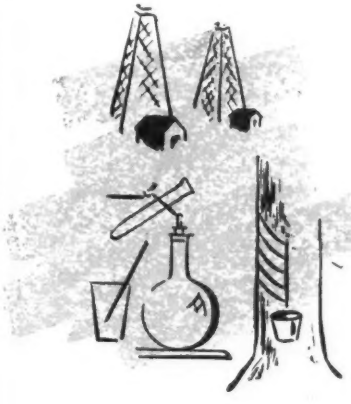
points the way to better Airplane Tires



Even before Pearl Harbor, "U. S." tires made with Nylon cord bodies were tested on military aircraft. These Nylon tires outperformed, in carcass strength and in ability to "take it," even the finest of the rayon construction which had been pioneered and perfected by the United States Rubber Company. The results of these military tests under actual service conditions confirmed beyond doubt what already had been found in the laboratory and on the highway.

Many other tests have been conducted in the "U. S." laboratories and in actual service. A six-ply Nylon tire was tested against an eight-ply rayon tire of identical air capacity. The results showed that although the Nylon tire was four pounds lighter and contained 1.7 pounds less rubber, it had a 25% greater strength rating than the rayon tire. Problems have been met and solved. But still the properties of Nylon tire cord are not fully understood. United States Rubber Company research men are testing, experimenting, searching for answers that still lie ahead.



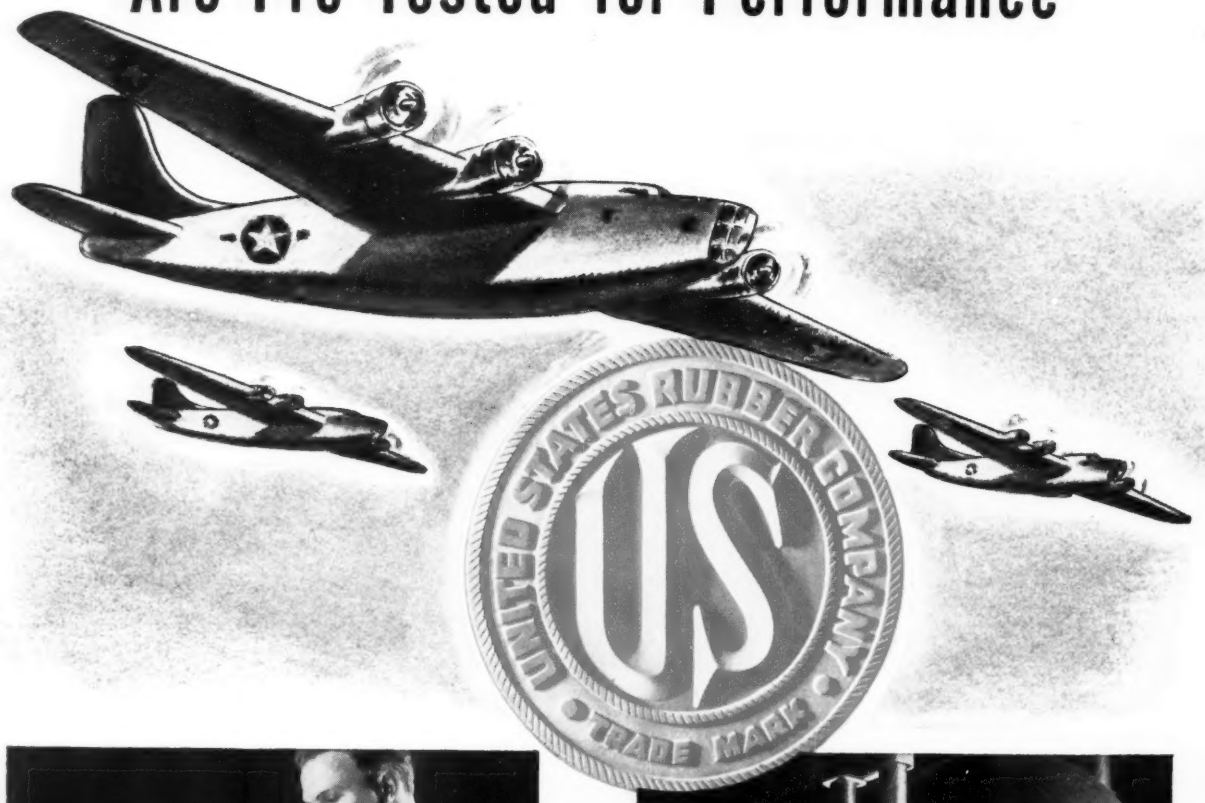


With its lightness of body, its giant strength in relation to thickness, Nylon may well point the way to stronger, safer, lighter, far better tires for your airplane and for your automobile. Although known to the world only since 1939, Nylon already has proved itself to be a substance of great value. But whether made from Nylon, from rayon, from cotton cords or from spider-web-thin steel, from synthetic rubber or from the natural milk of the rubber tree, "U. S." will build better and better tires—as its technical men open up new methods and new materials to the America of tomorrow.

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue • Rockefeller Center • New York

U. S. Royal Airplane Tires and Tubes Are Pre-Tested for Performance



Airplane tires have to be built to close tolerances to fit into crowded nacelles, forks and struts. U. S. Royals are frequently taken from production, mounted, inflated and checked against specifications.

Accurate instruments automatically record deflection of every type and size of U. S. Royal Airplane tire. Copies of these deflection charts are available on request.

ONLY "U. S." HAS THESE EXTRAS

1. **TEMPERED RUBBER TREAD**—A tougher, scuff- and heat-resistant tread compound for airplane tires.
2. **SAFETY-BONDED RAYON CORD**—A lighter, more resilient, airplane tire material with tremendous impact resistance and stamina at high temperatures.
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4. **"U. S." ICE GRIP TREAD**—A tread of revolutionary design and performance for snow- and ice-covered landing surfaces.
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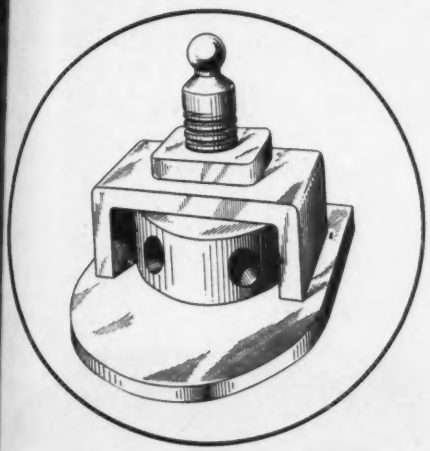

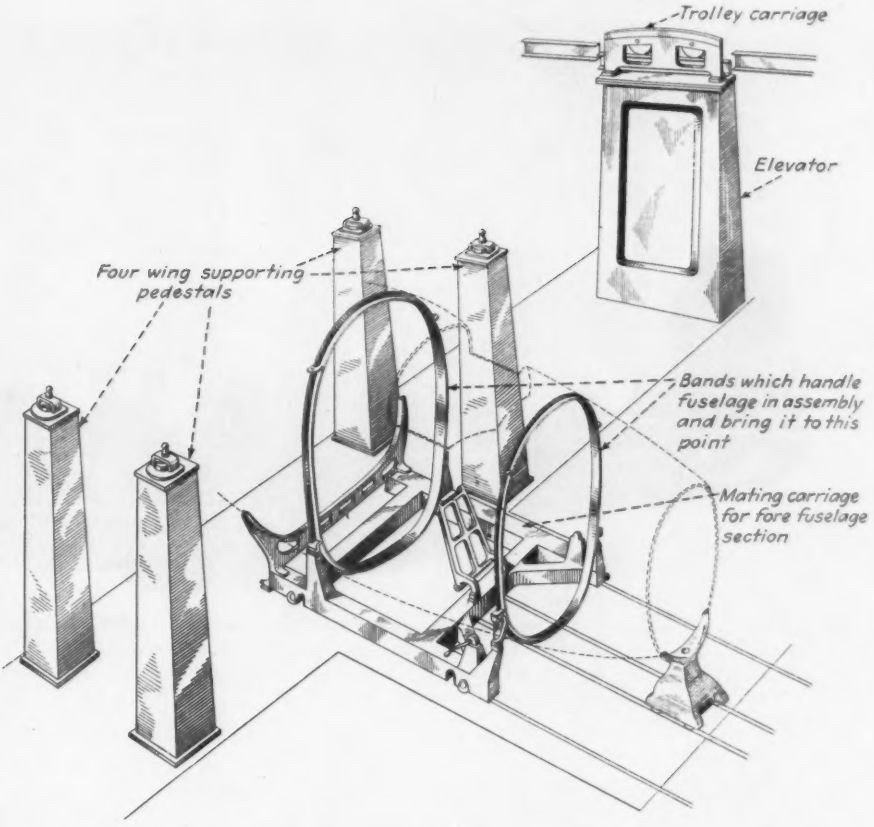
Trolley carriage
Elevator
Four wing supporting pedestals
Bands which handle fuselage in assembly and bring it to this point
Mating carriage for fore fuselage section

Author's sketch shows fixture for mating wing center section and nose fuselage. Wing is brought to fixture by trolley carriers (the left one being at upper right of sketch) that move onto elevators which lower wing section onto four wing-supporting pedestals. Inset sketch shows details of adjustable ball-ended locator on top of each pedestal. Mating carriage, with nose fuselage straps, is located between pedestals and is rolled back into position.

able to flat or corrugated sheets, was designed for this job.

Taylor-Winfield automatic welders sew these pieces together at the rate of 45 spotwelds per minute, the spots being automatically spaced.

All aluminum tubing for hydraulic lines is bent in one department, with all kinds of bending devices in use due to the lack of supply of any one kind. Today, more and more of the tubing is being formed in fiber-faced radius blocks after it is filled with Cerro-bend. This is preferred to bending on a mandrel because the inside of the tube does not have to be cleaned of drawing lubricant after bending. The Cerro-bend leaves a clean tube when it is dipped in boiling water and the alloy has run out.

The new spar assembly line is typical of developments at Willow Run today. Rivet hole drilling follows standard

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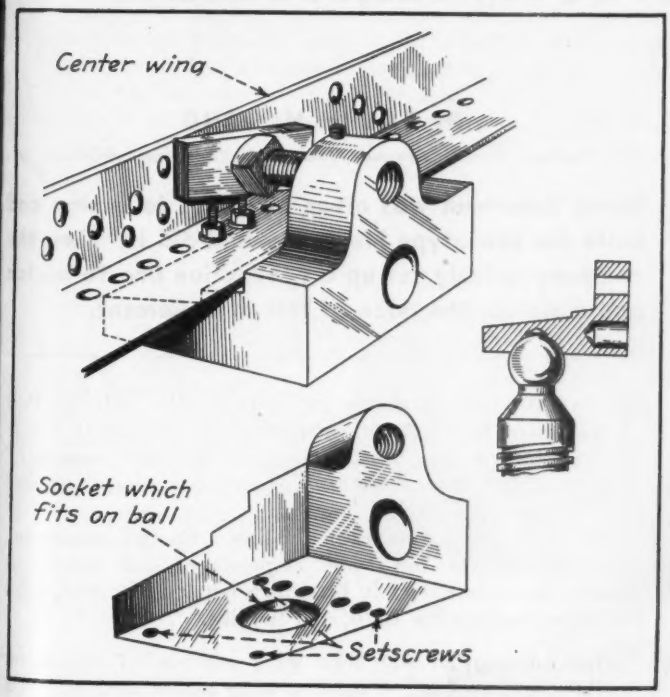
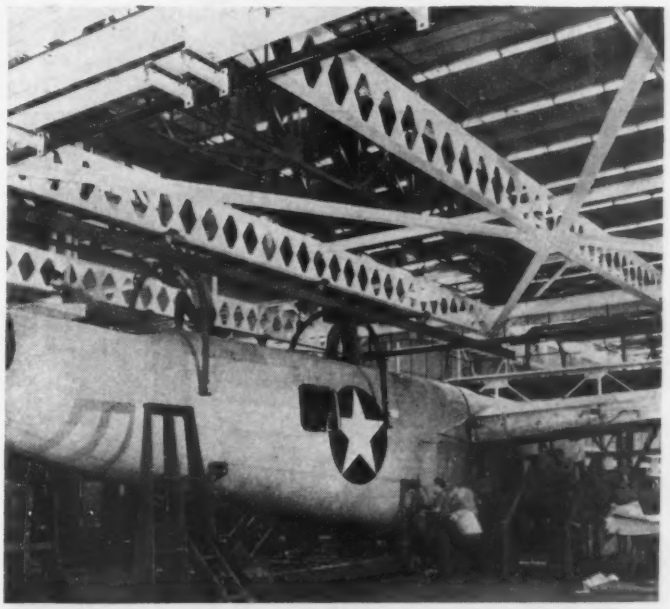
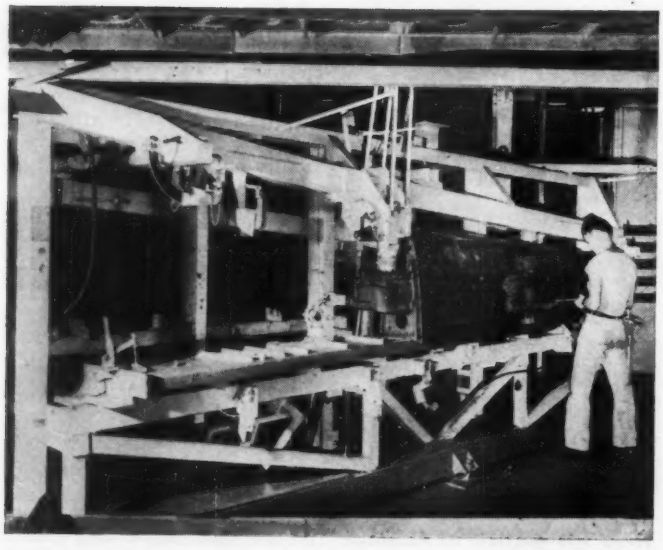


Details of front center wing section positioning pad, which fits over ball-end locator atop each of four pedestals at nose fuselage and center wing section mating fixture.



Here aft section of fuselage has just been mated with center section, which still rests on mating pedestals. Upper parts of aft fuselage straps are just being removed by crane while section is cradled in lower parts on mating car. When unbolted, lower portions of straps slip out from under fuselage as wing and fuselage are lifted off mating points. Aft mating car is then withdrawn.

"Mustangs" by North American



To the main spar, outer and inner pre-assembled portions of the leading edge "quarter" of a wing are added in this jig, also the big landing gear casting. Riveters are shown at work on an outboard section. A similar inboard section will be joined next to the spar section in the foreground.

By RALPH H. RUUD

Asst. Factory Mgr., Inglewood Plant, North American Aviation, Inc.

North American was given 120 days to design and build the prototype *Mustang*—and did it. Then the company quickly set up a production line to match and maintain the pace of this achievement.

TO ATTAIN its remarkably rapid production rate of P-51 *Mustangs,* North American employs a component assembly technique calling for a minimum of "final assembly." Equipment and accessories are virtually completely installed before the components are joined.

There are five major assembly lines: Engine accessories, fuselage, fuselage tail cone, empennage, and wings. A number of minor assembly lines turn out landing gear, pilot housings, fuselage fire walls, and the like.

The *Mustang* laminar flow wing consists of two outer panels joined together without a wing center section. As a production component, it consists of four quarters: Right and left leading edge sections, and right and left trailing edge sections.

Trailing edge sections of the *Mustang* wing, rights on one line and lefts on the other, move toward the station where they will be joined to the leading edge section. Pickup assembly and installation work is done on this line which, having been powered since photo was taken, now moves continuously.

Through a well between work platforms, the wing panels pass while work on them progresses from two levels and on both sides simultaneously. At the end of this leg of the line, panel will be camouflaged in a paint booth, where it moves sidewise and then emerges to proceed down the second leg.

Assembly of leading edge sections is started in stationary jigs, with two or more parts being joined. These, in turn, are joined, step-by-step, until a substantial section is completed.

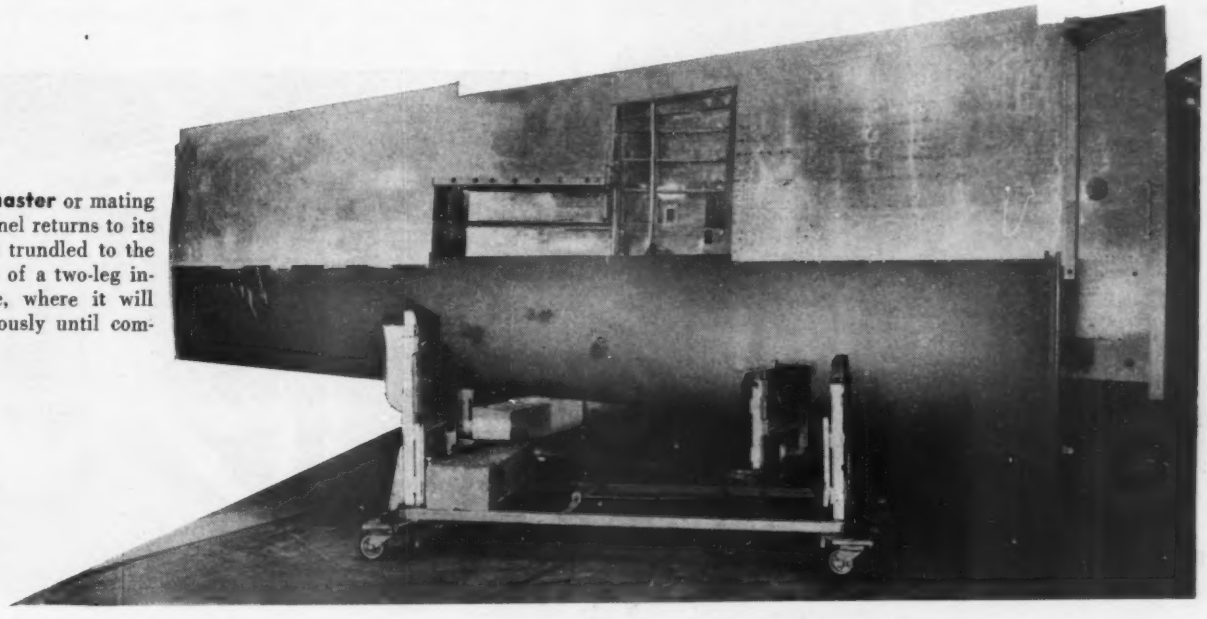
Spars, for example, start as short, pre-formed channel sections to which stiffeners and brackets are added. These are joined—an outboard to an inboard section—to form a leading edge or main spar. Then begins the addition of ribs, stringers, and skin, all done in stationary jigs. To the spar is added already assembled outer and inner portions and the main landing gear casting. Combined, these represent roughly 30 percent of a completed wing.

When securely joined, the leading edge section of a right or left wing panel is attached to a floor carrier, the casters running on the floor itself, where it will move continuously through 24 stations of two legs of a line, to emerge with a major portion of its installations already in place, for joining to a trailing edge section. The latter, likewise, begins in jigs and is transferred to a floor carrier line, but this one has only one leg, ending at the joining jig for union with the leading edge section.

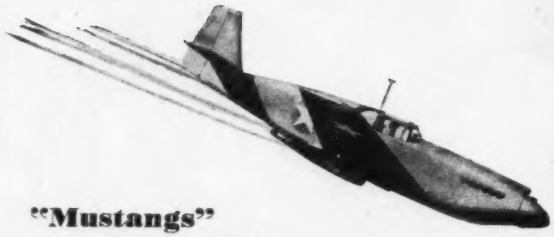
The two "quarters" are removed from their carriers and literally "stuck" together in another carrier, in a vertical position with the leading edge held in the cradle of the carrier and the trailing edge resting on top of it. In this carrier, the stuck-together sections—they have not been riveted or in any way actually fastened together as yet—move into a master joining jig, where they become a right or left wing panel, as the case may be.

Upon emerging from the master jig, the now securely joined panel moves into the first of two legs of a continuously moving line containing 17 stations, where tie-together work is finished and installations are made. After emerging from a paint booth at the midway point (the right and left panels alternating on the line) they are joined before progressing back toward the starting point of this two-leg line.

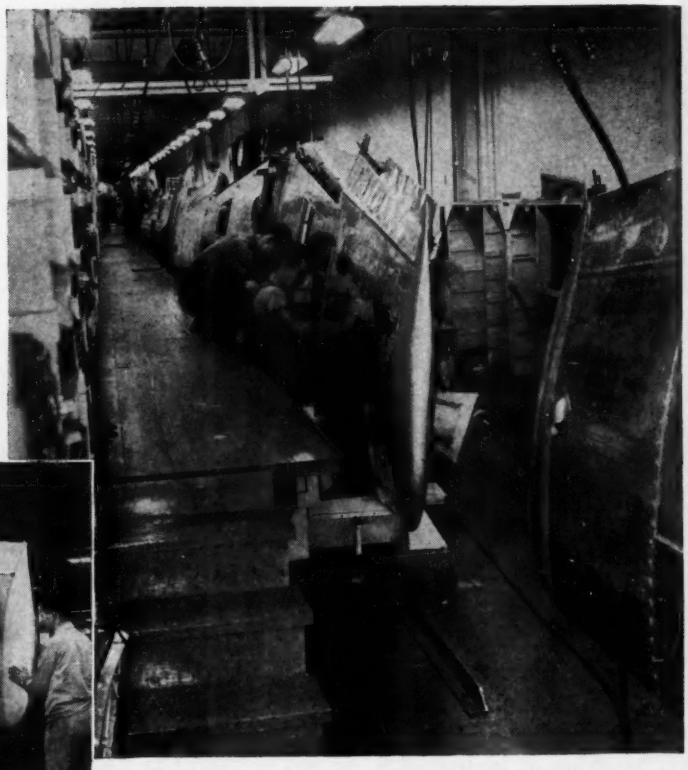
On this second leg, major installations are made, including the landing gear and the control stick mechanism. When the



Out of the master or mating jig a wing panel returns to its carrier and is trundled to the starting point of a two-leg installation line, where it will move continuously until completed.



"Mustangs" By North American



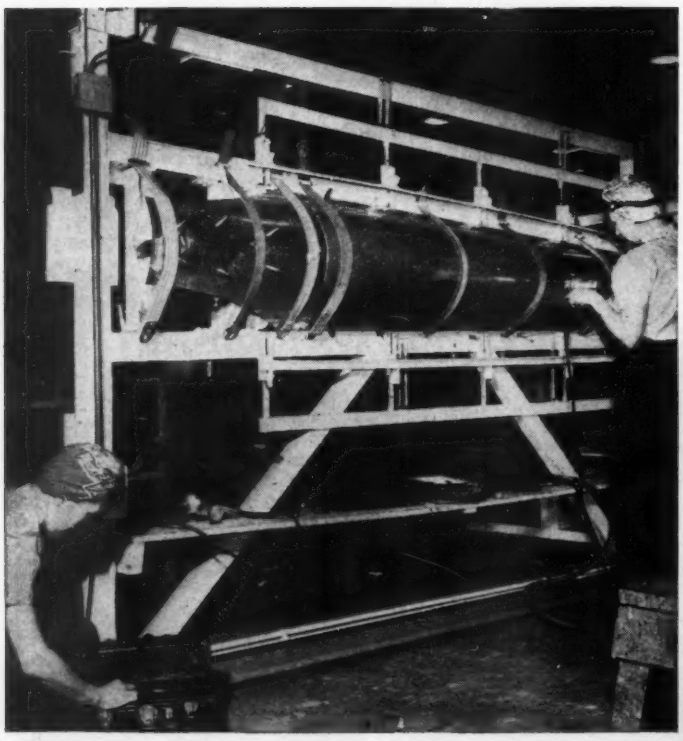
In the first section of the second leg of the wing installation line, right and left panels are joined. As they progress, moving continuously, flaps, landing gear, wing tips, control stick assembly, and other installations are added.

When wing is completed it is trundled to the head of the final assembly line. Note that control stick mechanism is already in place. Since photo was taken a paint booth at the midway point of wing final assembly line has been put in service and wings now reach this stage completely painted. Ailerons are now also installed and rigged on wing line.

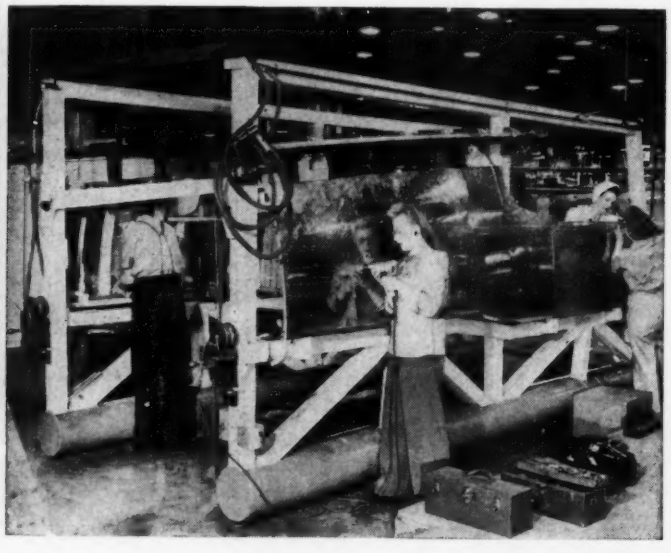
wing emerges, still on its carriers, from the last station of this line it is trundled by a crew of handlers to the head of the final assembly line where it is transferred to another carrier, this time in a horizontal position, and the fuselage is lowered onto it and joined, in the first station.

A feature of the leading edge line that has contributed considerably to its efficiency is the extreme to which the work is broken down. So specialized are the jobs that only one, two, or three persons work in each station. Because they do only one or two small phases of the work in each of these stations, and there is no congestion of workers, they become highly proficient and can do their assigned jobs while the line moves slowly through the station.

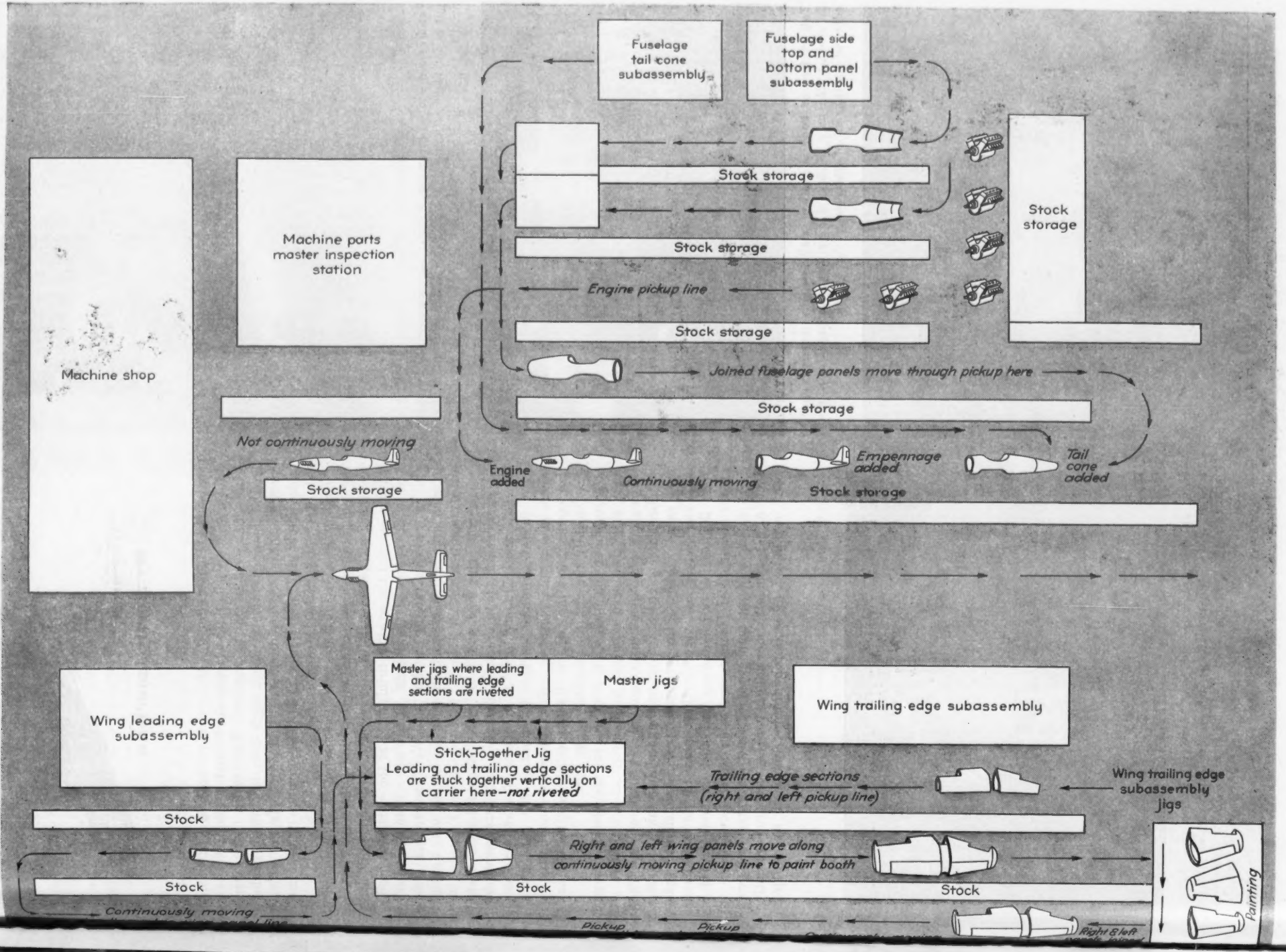
Another feature of this line is overhead compressed air and electric lines, with tools suspended from them on trolleys that travel with the work through the station. This eliminates

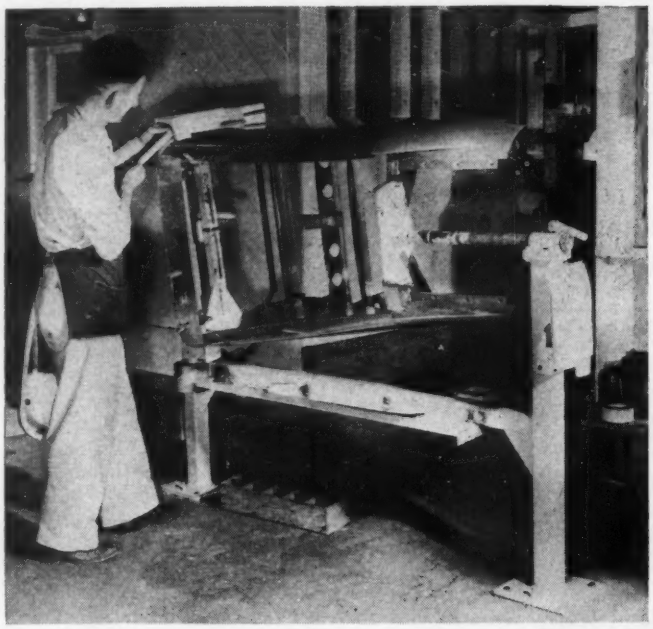


Top deck of fuselage is assembled in stationary jigs.

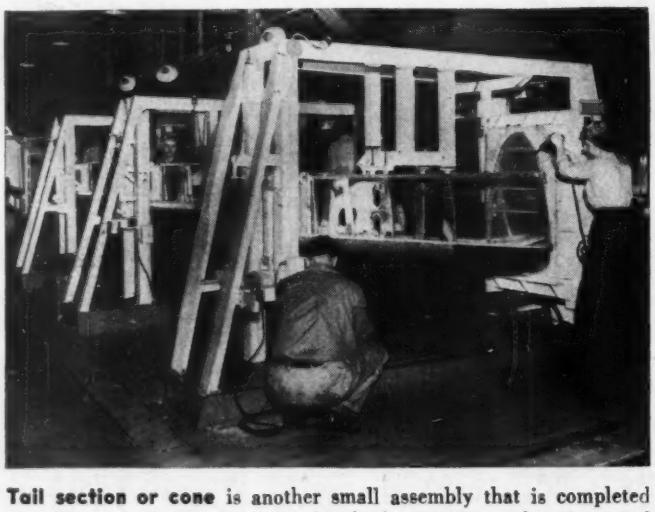


Right and left side panels of fuselage are assembled in two-sided jigs like this one.

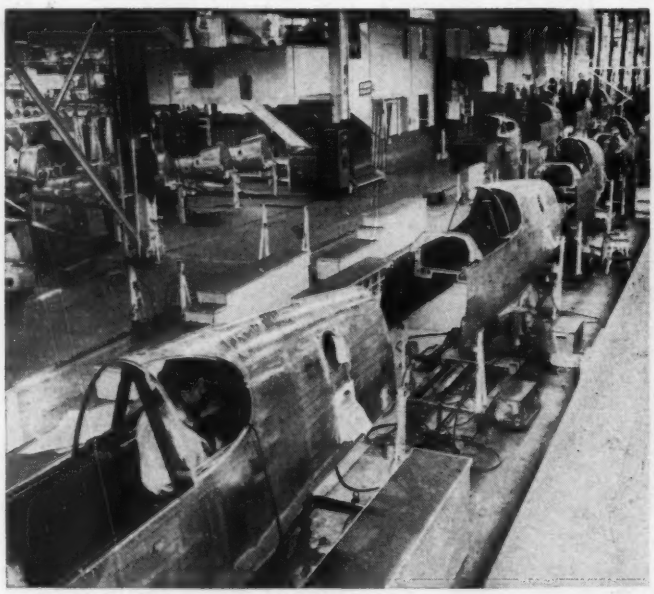

Fuselage tail cone subassembly
Fuselage side top and bottom panel subassembly
Stock storage
Stock storage
Stock storage
Stock storage
Machine parts master inspection station
Machine shop
Engine pickup line
Joined fuselage panels move through pickup here
Stock storage
Not continuously moving
Stock storage
Engine added
Continuously moving
Empennage added
Tail cone added
Stock storage
Master jigs where leading and trailing edge sections are riveted
Master jigs
Wing leading edge subassembly
Wing trailing edge subassembly
Stick-Together Jig
Leading and trailing edge sections are stuck together vertically on carrier here—not riveted
Trailing edge sections (right and left pickup line)
Wing trailing edge subassembly jigs
Stock
Right and left wing panels move along continuously moving pickup line to paint booth
Stock
Stock
Painting
Continuously moving
Pickup
Pickup
Right & left



The bottom scoop assembly is small and composed of few parts, but is put together in jigs, such as this one, for later quick attachment to the fuselage as a component.



Tail section or cone is another small assembly that is completed on a short stationary jig line of only four stations, then is stored adjacent to its point of attachment.



On the pick-up lines, fuselage continues to acquire parts.

"Mustangs" By North American

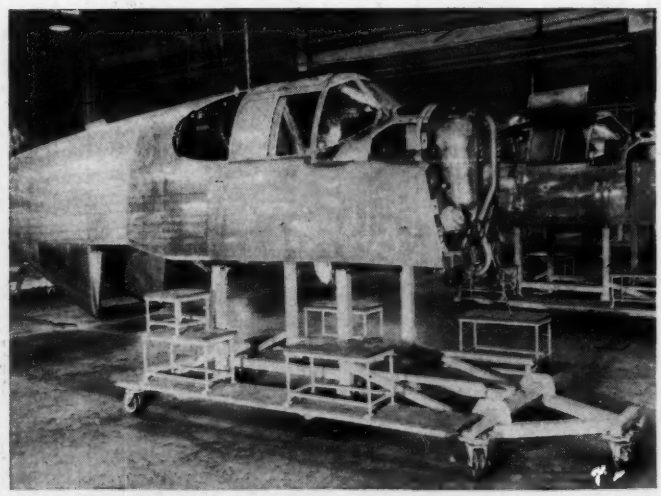
floor congestion and prevents excessive breakage of tools and snarls of hose and electric cords that would interfere with the movement of the workers. The carrier casters run on the floor astraddle a single angle iron rail which guides them by means of a slotted extrusion of the frame which slides along the rail. Power is applied through a dragline with connecting links between carriers.

One of the unusual features of the master jig, where trailing and leading edge sections of the wing panels are riveted together, is the accessibility provided. Critical points are established and the work is firmly held at the ends, overhead, and in the center at the bottom. There are no side members and very little framing in this jig. Workers can get close to each area and perform their tasks in normal standing or sitting positions.

The final wing line, too, is of rather unique design. Here the carriers roll along the floor through a well between working platforms. Although only 30 in. across, this well provides room for some of the workers to stand on the floor while others are on the platform. Work progresses on both top and bottom of wing surfaces simultaneously as the sections pass steadily through the stations of the line.

Throughout the plant, which of course includes the wing lines, stock is stored adjacent to its point of use. There is no routine or paper work involved in obtaining it. The installer merely reaches over to the bin and takes out the part as he needs it. Production control responsibility ends with the delivery of parts to these point-of-use racks and bins. Responsibility for damage and stock-on-hand is placed on the shoulders of leadmen and other supervisors.

An example of the team work between designing and production departments, mentioned earlier, occurred recently when installation of certain hydraulic equipment was shifted



New carriers, such as this one, were introduced on fuselage pick-up and installation lines. Wheels are grooved and run on inverted angle iron rails. Feet of stands fit over edge of frame and prevent tipping but permit sliding them to desired positions. Wheels on triangular extension in front afford additional stability when engine is added to fuselage.

rom the fuselage to the wing departments. Production found hat it could do its work more efficiently if the location of ertain hydraulic valves and tubing could be shifted from he fuselage to the wing. Design promptly ordered the hange and found a place in the wing for the bothersome quipment. Similarly, the control stick installation, normally nade when the fuselage is in place on the wing, was shifted o the wing department because this permits rigging of the ileron by the wing department, a function normally accomplished by final assembly.

A point it might be well to stress here is that the layout of the several departments adheres to a rule that the travel of finished components is never far, generally not over 20 ft., before the components reach their next point of use.

The wing department is laid out right and left of a horizontal center line, with leading edge work being done on one side and trailing edge on the other. Both flow toward the center. Final wing assembly line starts at this point and returns to it when the wing is completed. It is out through this center line, actually an aisle, that the completed wing is trundled to the final assembly line for joining to the fuselage.

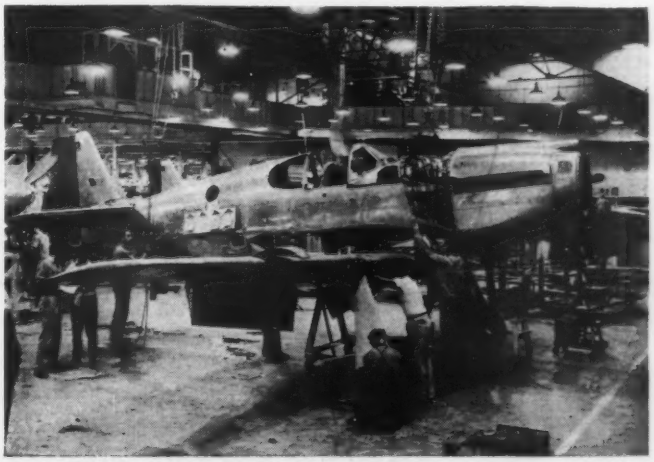
In the fuselage department, the breakdown of components is carried to a greater extreme than is common in aircraft manufacture. The main fuselage section begins in stationary jigs where the air scoop, bottom, top deck, and side panels are assembled as small units, each growing by the addition of other assemblies until a completed component is obtained, in most instances with a major portion of its installation in place. Here, too, the jigs are notable because of their wide open design that permits the fullest possible accessibility. Installations begin, as a rule, in the third or fourth step through which such assemblies pass. The wide open design of the jigs makes possible this early start on installation work.

The tail section or "cone", having few installations, starts in a stationary jig and then passes through a short, four-station line, the last one of which is for installations. Four of these lines, side-by-side, provide the necessary volume.

Side panels, likewise, start in stationary jigs but are transferred at an early stage to carriers on which they progress through three stations before entering a paint booth

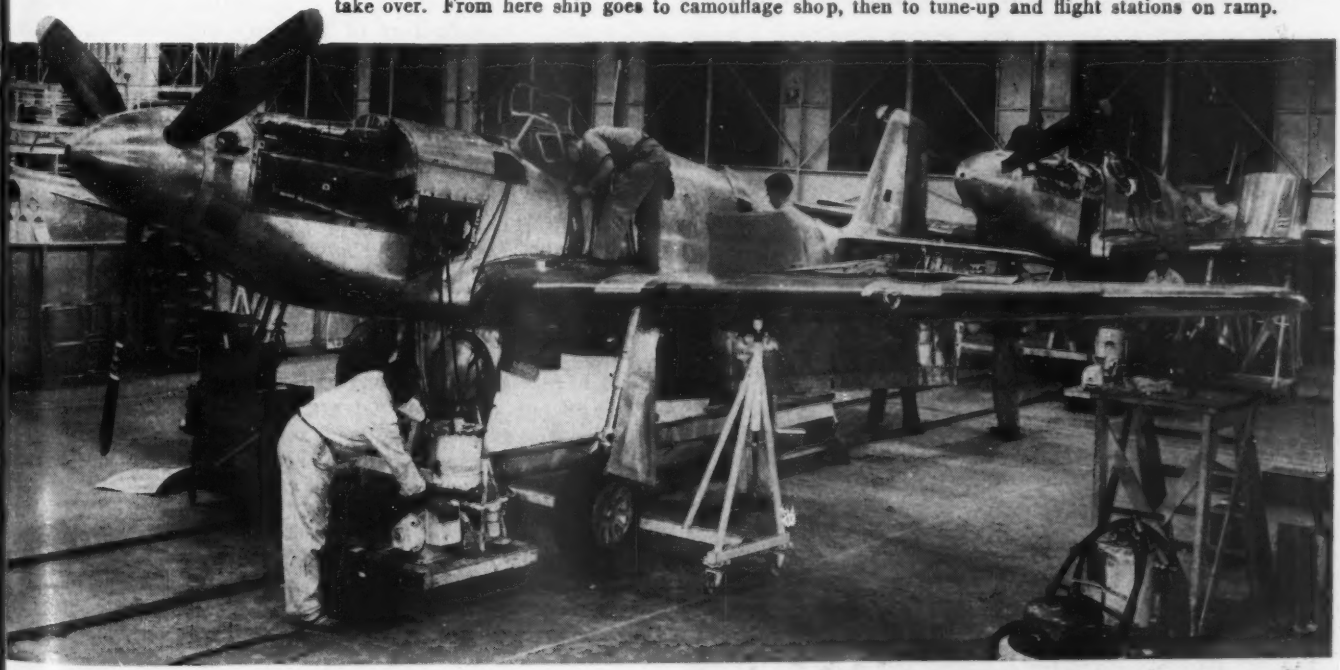
(*Turn to page* 325)

Engines enter this line at left of starting point in background, progress through nine work stations as they acquire mounts, equipment, and cowlings.



In first station of final assembly line, wing (shown in a previous photo) is attached to a landing-gear-high carrier and the fuselage is lifted from its carrier and lowered into place. Man in cockpit is guiding fuselage and directing operation.

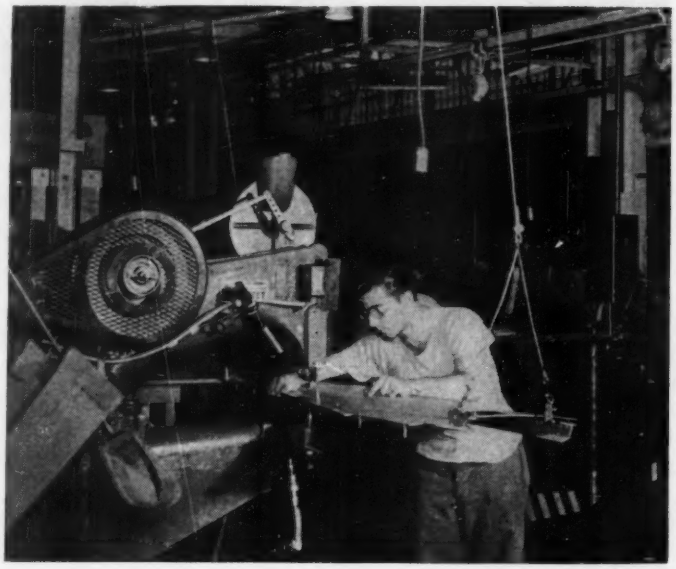
In two of the last three stations of the final assembly line company and government inspectors take over. From here ship goes to camouflage shop, then to tune-up and flight stations on ramp.



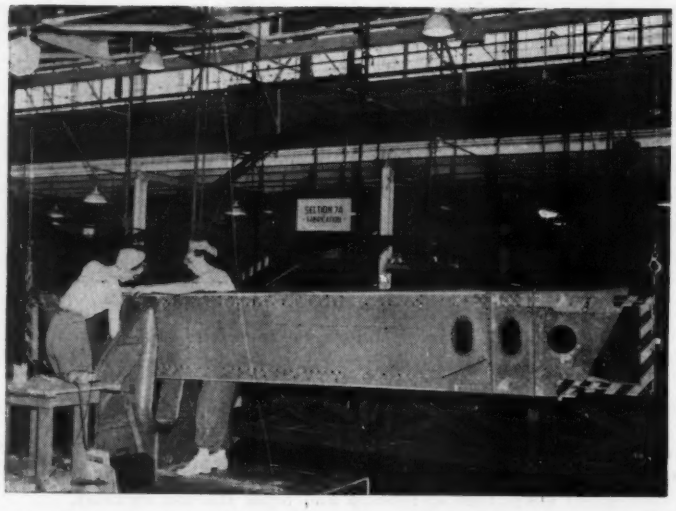
"Avengers" By Eastern

By HERBERT CHASE

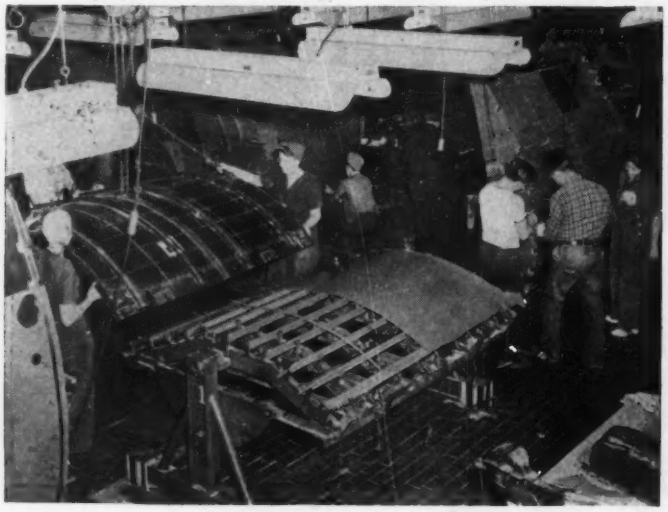
Many stations, each with few operations and maximum break-down into subassemblies, help General Motors' aircraft division expedite production of famed Grumman-designed Navy torpedo bomber planes.



Many medium size subassemblies are put through automatic riveters such as this. Handling is greatly facilitated by attaching a sling at both ends to a trolley on an overhead track, making the work exceptionally easy to shift both longitudinally and transversely.



Riveting of relatively heavy center section wing beam is much simplified by supporting work in vertical plane from spring hoists on trolleys and turning squeezer on its back where girl operators can see both bucking and rivet-setting tools.



One of many fixtures which hold such parts as ribs and longerons in position while they are drilled. Drill jig at left is about to be set over fixture after remaining skin section is applied. Clecoed subassemblies, ready for riveting, are in background.

EVERYBODY KNEW that a tough job had to be done when part of the fabrication and all the final assembly of the Navy's *Avenger* torpedo plane were assigned to a plant of the Eastern Aircraft Div., General Motors Corp. The Division's chief asset was a group of engineers and executives possessing a good knowledge of quantity production methods (though none had been in aircraft work) and plants, one of which happened to include a long high bay served by a crane. This latter was adaptable to the assembly of a plane having a fairly large wing spread.

Engineers and production men were, and still are, keenly aware that aircraft manufacture presents its own difficult problems and that it would not be easy to acquire the "know-how" quickly. This is especially true of a plane which is among the more complex types. Besides having to learn lessons in fabrication, it was necessary to triple personnel and to train not only the supervisory force but the whole group of workers retained, plus twice as many more who possessed little or no factory experience, including a large proportion of women.

Naturally, the organization was greatly aided by Grumman Aircraft Engineering Corp., which designed the *Avenger* and already had it in production. Eastern's supervisors were given the benefit of Grumman skill and every facility for learning how Grumman did the job. Just as naturally, efforts were made to apply the prior knowledge of quantity manufacture of Eastern's organization, and to adapt it to the solution of the problems faced, where this seemed promising. There is, however, a vast difference between the manufacture of a few thousand sets of automobile hardware per day (the prewar job done in the plant here referred to) and the making of a relatively few large and intricate planes in the same time.

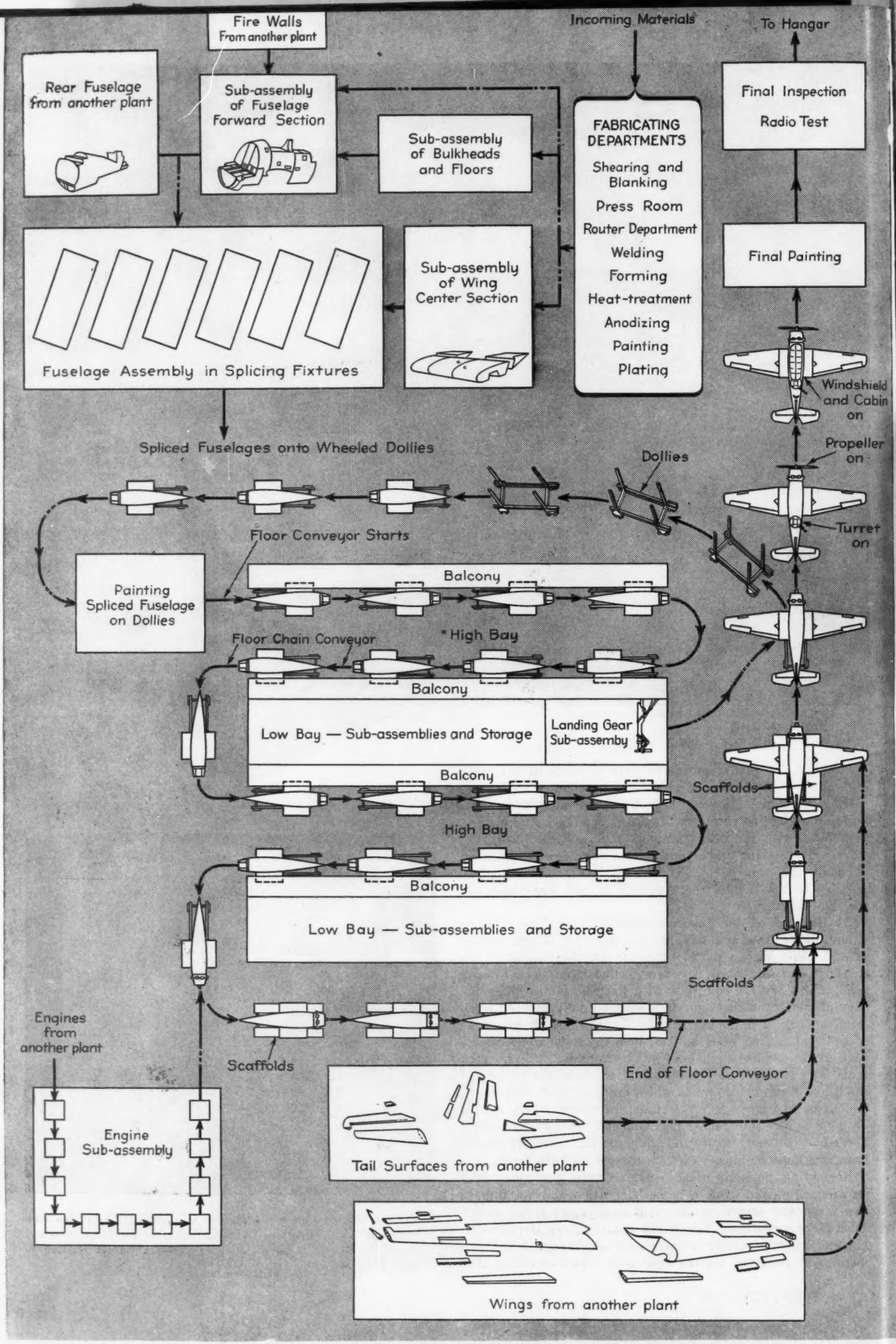
Fortunately, parts of the job were assigned to other Eastern plants. One plant took on the manufacture of wings. Another is making the rear fuselage and tail surfaces, and still another supplies tubing and electrical subassemblies. The engines, turrets, struts, and many other components come from other suppliers. This leaves the plant here dealt with to fabricate the forward fuselage section and the center wing section as the only large major units, but numerous smaller subassemblies are made and a host of other elements are received as small parts, complete units, or minor subassemblies.

Most of the plant considered here consists of alternate high and low bays, none of which could accommodate a large assembled plane. As some bays were not high enough for building an entire fuselage, the main assembly line follows high bays, with the intervening bays being used partly for storage, for making and repairing tools, and for the assembly of small units and parts. These areas are as convenient as possible to the points where the units built are needed in the final assembly.

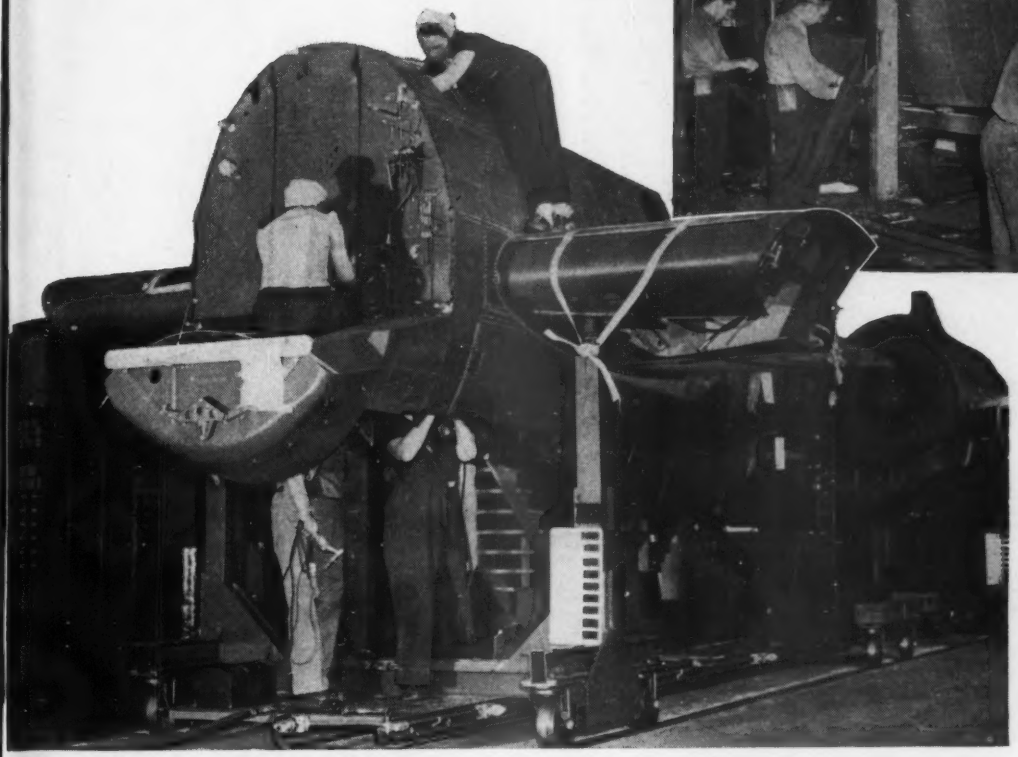
At the end of the fuselage assembly line, the fuselage enters the wide crane bay and receives its wings, among several other major parts. Because of the height of the fuselage and the need for doing much work above wing level, high bays are equipped with fixed balconies along the edge of which the fuselage, on a wheeled dolly at floor level, is advanced. This makes it easy for workers to enter the cockpits at a high level and to do many jobs which otherwise would require high and bulky scaffolds. Others work from floor level. This arrangement facilitates the supply of small and medium size parts which are needed at both levels, and gives bench space for certain operations which cannot be done in pre-fabricating departments. Many small parts needed in assembly work and all tools for assembly operations are kept in bins, racks, or lockers on both levels.

Remaining portions of the plant, comprising about half its area, are given over to basic fabrication and building of two large and several small subassemblies, as noted above. Such departments as the press room, router department, hammer room, welding department, anodizing, heat-treatment, and painting departments take about one-fourth of

Center wing sections are assembled in several rigid fixtures such as shown. One important locating point is at hinge forgings through which pin is passed to hold parts in correct relation to fixture lugs.


Fire Walls
From another plant
Incoming Materials
To Hangar
Rear Fuselage
from another plant
Sub-assembly
of Fuselage
Forward Section
Sub-assembly
of Bulkheads
and Floors
FABRICATING
DEPARTMENTS
Shearing and
Blanking
Press Room
Router Department
Welding
Forming
Heat-treatment
Anodizing
Painting
Plating
Final Inspection
Radio Test
Final Painting
Fuselage Assembly in Splicing Fixtures
Sub-assembly
of Wing
Center Section
Windshield
and Cabin
on
Propeller
on
Spliced Fuselages onto Wheeled Dollies
Dollies
Turret
on
Floor Conveyor Starts
Painting
Spliced Fuselage
on Dollies
Balcony
Floor Chain Conveyor
* High Bay
Balcony
Low Bay — Sub-assemblies and Storage
Landing Gear
Sub-assembly
Balcony
Scaffolds
High Bay
Balcony
Low Bay — Sub-assemblies and Storage
Scaffolds
Engines
from
another plant
Scaffolds
End of Floor Conveyor
Engine
Sub-assembly
Tail Surfaces from another plant
Wings from another plant

"Avengers" by Eastern



Many subassemblies are put together in center section fuselage fixtures of this type, correct fits being assured by fixtures used in prior operations, which also minimize time for building this major subassembly. Scaffolds are placed along sides of fixture as needed.

Close-up of dolly which carries fuselage along edge of balconies from which assemblers reach upper portions of plane and easily enter cockpits, while others work (especially in bomb bay) from dolly platform slightly above floor level.

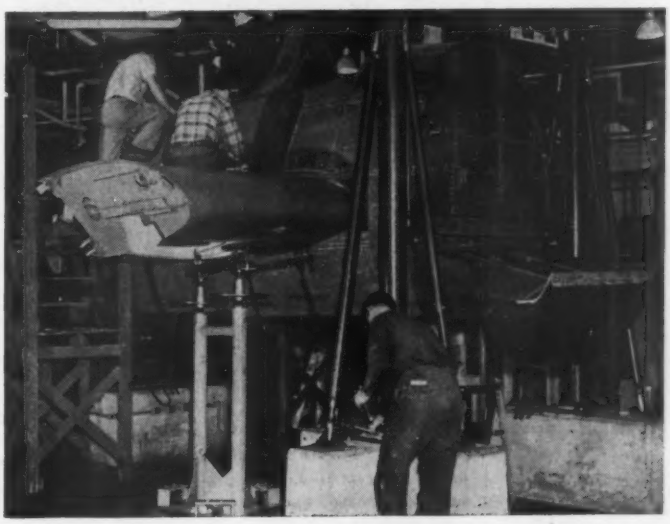
the plant. These, together with a machine shop, which is on the second floor over one side of the plant, feed fabricated parts into the major and minor subassembly departments. At the proper time, small subassemblies are advanced to the fuselage assembly and main assembly lines. Fabricated units coming from other plants are fed in where needed in the respective assemblies.

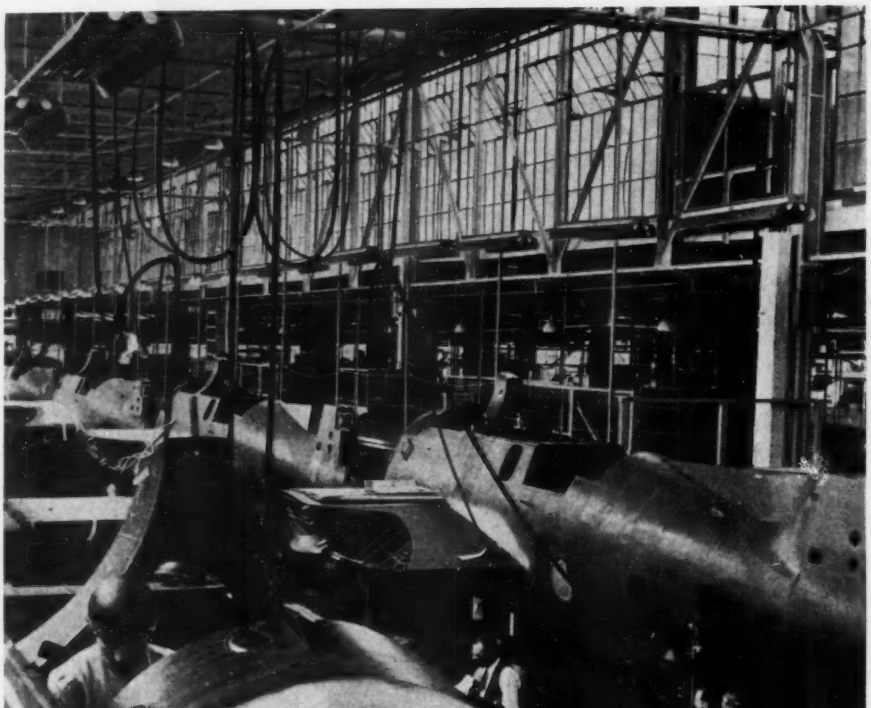
All the large sub-assemblies which enter into the main fuselage assembly are built in fixtures similar to, though not identical with, those employed by Grumman. Policy has been to break down into small subassemblies as many as possible of the elements which are needed in the large subassemblies. In other words, instead of centering the work largely in big fixtures in and around which many workers must perform many operations, these jobs are divided so that they are done at many separate stations. At each of these is usually a smaller fixture where one or only a few workers perform relatively short repetitive jobs, always with ample space.

These fixtures assure fits when the small subassemblies are transferred to the larger fixtures. This method also has the great advantage that workers can quickly learn their jobs, since the work is simple and often repeated, and that a large number of individuals contribute to the large subassembly without getting in each other's way. Moreover, by employing assembly fixtures as well as numerous drilling jigs from the smallest subassemblies upward, precise interchangeability is promoted. When a small subassembly reaches the next larger subassembly it fits and is built into the larger subassembly with a minimum of labor.

Schematic diagram indicating how flow of parts and subassemblies proceeds from fabricating departments to final assembly.

One of several splicing fixtures in which major fuselage elements are joined. This is final step before assembly is placed in dolly on which it is advanced for nearly a mile while numerous items of equipment are installed.





A high bay with balconies at each side along which fuselage is advanced on dollies by a floor chain. Dollies, connected in series, receive current and air from looped leads supported above center of bay. Assemblers wear fiber helmets.

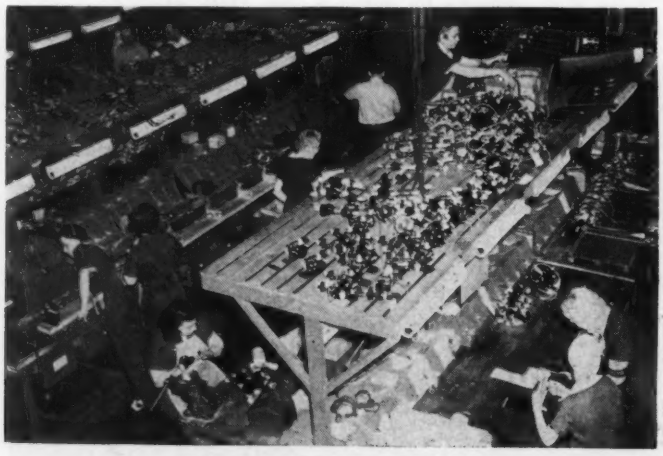
As far as possible, assembly lines are set up for a regular progression from station to station and so that progression is toward larger and larger assemblies. Most smaller assemblies are shifted from station to station by hand, as they are light and the distances small. Racks for small banks of parts are provided between many stations so that any unforeseen delays at one station will not result in stoppage at following stations. Most large subassemblies are shifted to the next fixture on dollies, but where necessary trolley rails are provided for shifting from fixture to dolly.

Assembly of the major fuselage units is effected in a series of large splicing fixtures which occupy much of one high bay. The major locating points on these fixtures are supported on concrete piers and are checked for alignment by transit before each major assembly is started. Included in this assembly are the forward fuselage (to which a firewall built in another plant has been added), a center wing section, and a rear fuselage, the latter also coming from another plant.

The primary work done in these large assemblies is to splice these sections together. When completed, the assemblies are lifted by power hoists and are set into dollies which are wheeled along a guide rail paralleling the fixture line. When in the dollies, the assemblies undergo Navy inspection and any faults are remedied before the assemblies are cleaned of chips and advaned into a closed spray room for painting.

The dollies, which differ from those employed by Grumman and do not include any scaffolds, are advanced parallel to the axis of the fuselage and have four wheels which run on guide strips, except on turns. There the guiding is done by the center floor chain rail, the dollies being attached to the chain when they issue from the paint room. Dollies are, essentially, long narrow platforms about a foot above the floor. Fastened to the platform frame are four uprights which support the fuselage at four points, two near the forward end and two on a bar passed through a transverse tube built into the tail section of the fuselage.

Each dolly has numerous air and electric outlets to which portable power tools and lights are connected. These are tapped off through lines fastened to the dollies, and there are flexible connections between the dollies, so that the whole row at each side of each high bay is fed in series. Leads for these lines are swung overhead at the center of each bay, and the foreman in that bay must see that lines are plugged in and disconnected within a certain marked distance. As conveyor motion is extremely slow, connections do not have to be changed often and there are always at least two feed lines connected, except at the instant of the shift. As only one line is shifted at a time, the dollies are never without power. Leads are supported from overhead and thus are kept off the floor.



Hydraulic subassembly department in one of low bays, as seen from balcony in adjacent high bay. Subassemblies are substantially completed wherever possible before delivery to stock rooms or to adjacent lines for installation in fuselage.

Engine subassemblies are built up along this line, parts being taken from adjacent racks and benches as units advance on wheeled dollies. At end of line, subassembly is transferred by trolley hoist for joining to fuselage.

Dollies are so guided that the fuselage follows along the balconies, the low point of which just clears the top of the stub ends of the wing center sections. This makes it easy for assemblers who work from the balconies to enter either cockpit or to reach a platform which projects beyond the firewall at the front end. Each balcony has rope railings which are detachable in short lengths and which are replaced after the fuselage passes a given point.

Much of the work, especially in the bomb bay, is performed by employees at floor stations and is done from the dolly platform or from small one- or two-step movable plat-

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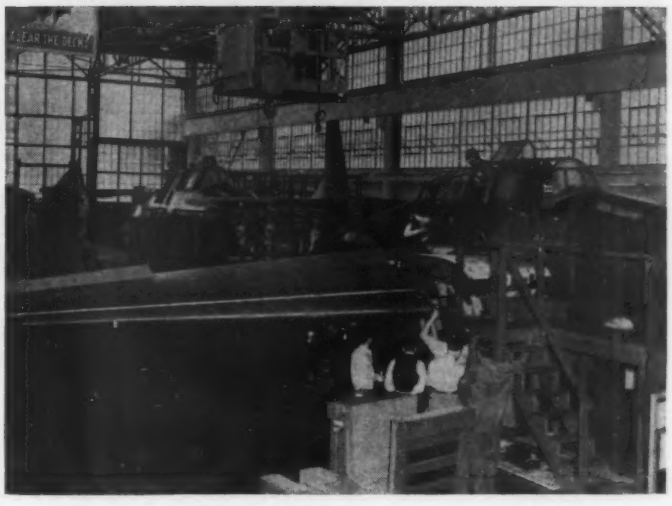

Crane bay in which tail surfaces, wings, turrets, cabins, and other units are installed. Wings are lifted from caster dollies or cradle (foreground) by sling attached to eyebolt at center of gravity. One man guides wing into place. Crane is operated by a woman.

At end of assembly line, planes enter paint room and are placed over exhaust gratings which carry off fumes from painting. Upper portions are sprayed from scaffolds on casters after propellor and other portions are masked.

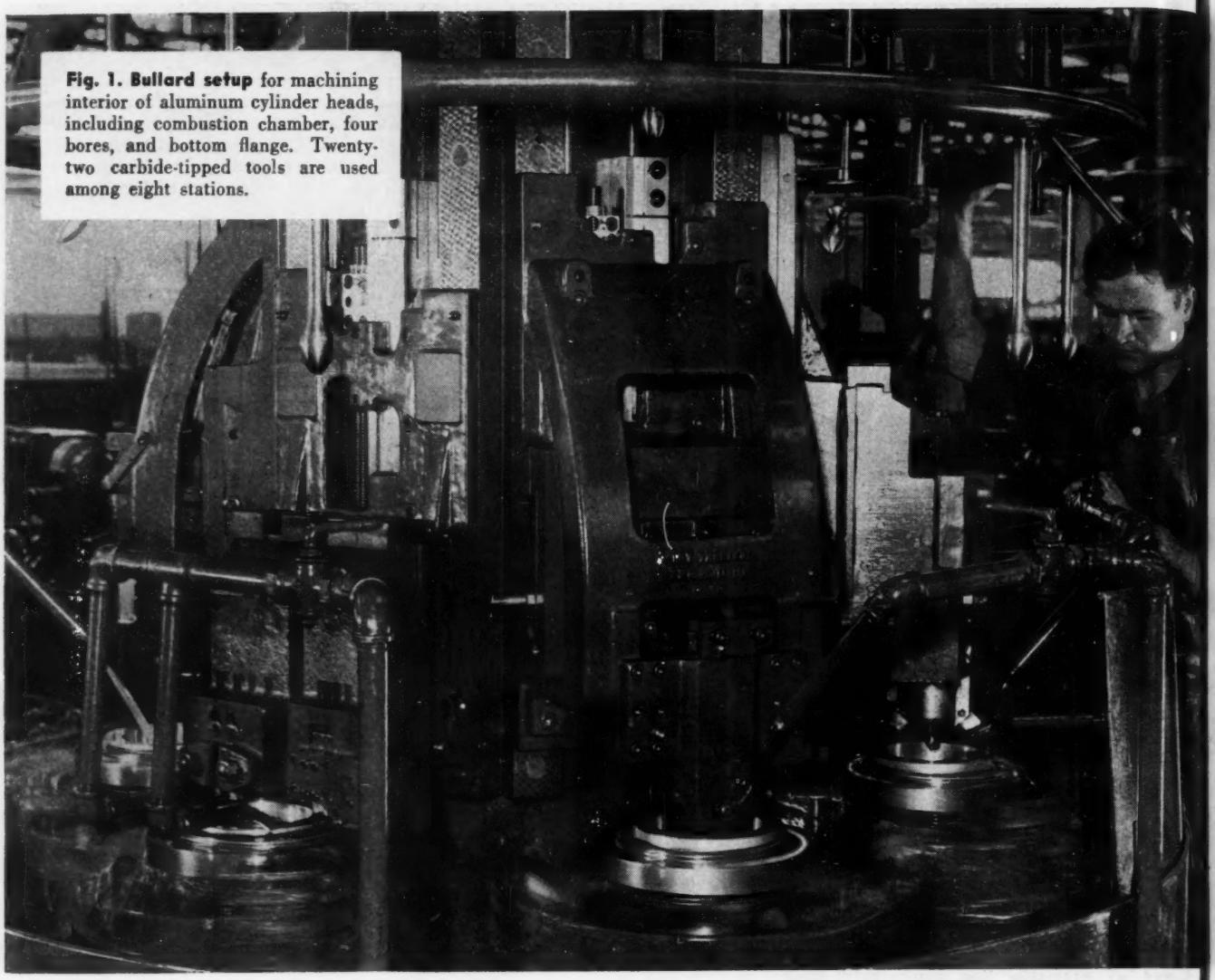

Fig. 1. Bullard setup for machining interior of aluminum cylinder heads, including combustion chamber, four bores, and bottom flange. Twenty-two carbide-tipped tools are used among eight stations.

Buick Practice in Machining P & W Cylinder Heads

By HERBERT CHASE

In its well equipped plant Buick has put to good use all the latest and best methods obtainable from past experience by Pratt & Whitney. Combined with the study and efficient execution of their own engineers, Buick's production flows from a finely tooled, up-to-the-minute center of precision manufacture.

IT IS PROBABLE that nowhere in the world is there a finer or more modern plant for building aircraft engines than that put in operation by the Buick Motor Division, General Motors Corp. In planning and equipping the plant, Buick engineers studied the excellent facilities in Pratt & Whitney plants and sought to make the most of the latest machines available, just as P & W engineers would do if they themselves were retooling for the Pratt & Whitney 14-cylinder engine.

In this article, only the production of the cylinder head is dealt with, special stress being laid on those operations which differ in some respects from practice followed previously on the same part. Not all operations are included nor are all details released.

After the finned aluminum head casting has been cleaned and rocker box hole and port holes sand blasted, the casting is chucked in a Lodge & Shipley turret lathe and a locating lug is drilled, reamed, and faced, and the o.d. of the lower fins is turned. This yields locating surfaces for nearly all following operations, including initial ones done in a Bullard Multimatic vertical spindle automatic turret lathe, in which the inside dome of the head is machined and four inner diameters are rough- and finish-bored within plus or minus 0.002-in. limits. The lowest flange and the end of the head are also faced.

There are eight stations on this machine, and 22 tools in 16 holders or boring bars are used, the work being held in chucks which rotate about vertical axes. Tools are raised automatically when indexing to the eight

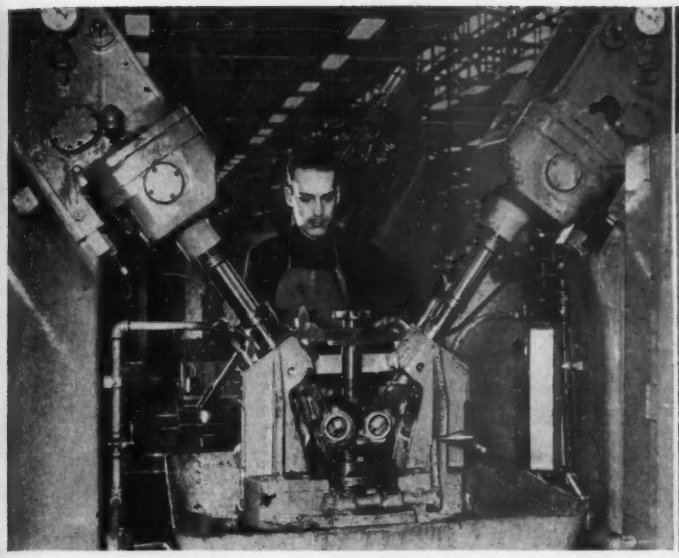

Fig. 2. Foote-Burt machine with two heads set at required angle for machining seats for inlet and exhaust valve springs. After roughing, fixture is indexed 180 deg. for finishing cut.

Fig. 3. Milwaukee miller for simultaneous facing of both rocker box faces, using two inserted blade end mills on a pair of heads set at proper angles, while cylinder head is held in rigid fixture.

stations and feed automatically while coolant is supplied to them.

In nearly all operations here described, carbide-tip tools are used, except for the drilling, tapping, and reaming, as they permit of rapid and accurate work and tend to minimize time out for sharpening and resetting.

In a subsequent operation, eight threads per inch are cut on one diameter of the bore in a Hall planetary thread milling machine. This provides a Class 3 fit with the male thread on the cylinder barrel when the latter is later assembled to the head. Following this threading, the head is clamped under air pressure in a fixture which seals the bore and the ports against rubber, after which water is forced in under 500 psi. pressure. If there are any pores in the casting, they are revealed in this test and the casting is scrapped. Sound castings are advanced to a Natco horizontal drill, in which intake and exhaust valve stem and valve seat holes are drilled, reamed, and counterbored.

A Foote-Burt drill press having two heads placed at the required angles is employed to machine the seats for inlet and exhaust valve springs, using a hollow mill and a facing mill. For this operation, the head is clamped in a special fixture, as shown in Fig. 2. After making the roughing cut, the fixture is indexed through 180 deg. and the second spindle makes the finishing cut, holding plus or minus 0.002-in. dia. limits and plus or minus 0.005 in. on depth.

Holes for rocker arm shafts are drilled, reamed, spot faced, and back spot faced (the latter with a cutter placed inside) on a Leland-Gifford angle-type drilling machine. Another machine of the same make, but having a single spindle, is used with a formed end mill to machine faces on the outside ends of rocker shaft holes.

To face both rocker boxes at the same time, the head is mounted in a fixture on the bed of a Milwaukee miller and passed under a pair of inserted blade end facing cutters set on separate spindles, each inclined to cut at the required angle, as shown in Fig. 3. This setup doubles the machining rate attained in other machines with only a single cutter.

To drill, ream, spot-face, countersink, and tap spark plug holes, a Natco drill press having five spindles is employed. It is equipped with a special fixture arranged to index around to six stations, one of which is for loading and unloading. As shown in Fig. 4, the fixture has swinging arms with latches and screw clamps for fastening the work, and indexing is done with a crank. Tools are controlled from push buttons. Another press of the same make is employed to drill, ream, and tap certain holes around intake and exhaust ports, using a four-station fixture.

A Cincinnati-Bickford drill press is applied with a fixture indexing about

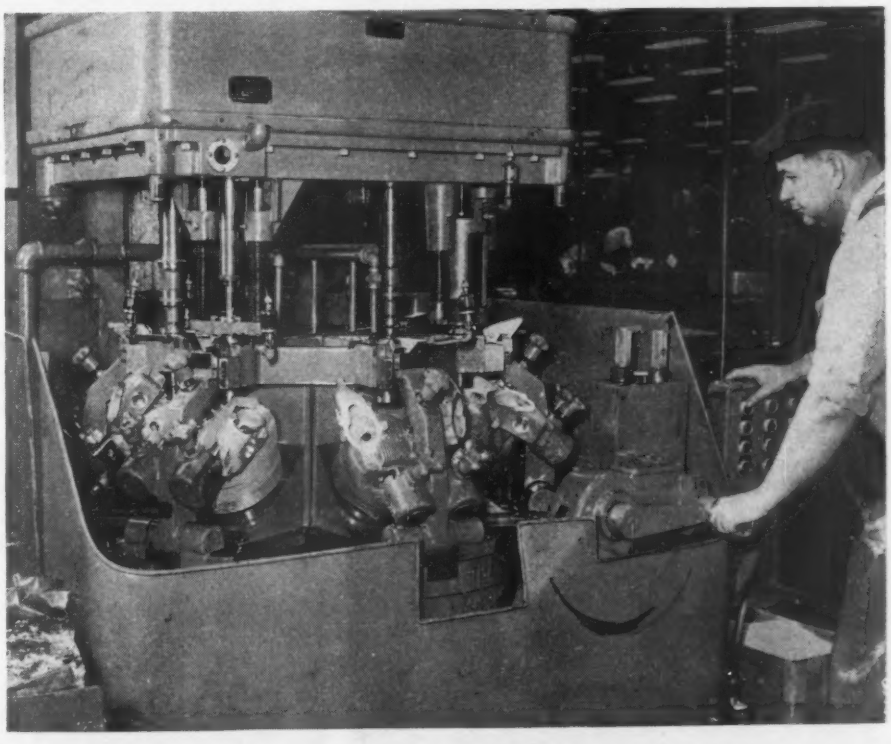

Fig. 4. This multiple spindle Natco drill press is provided with a six-station indexing fixture. Tools drill, ream, spot-face, countersink, and tap holes for spark plug bushings.

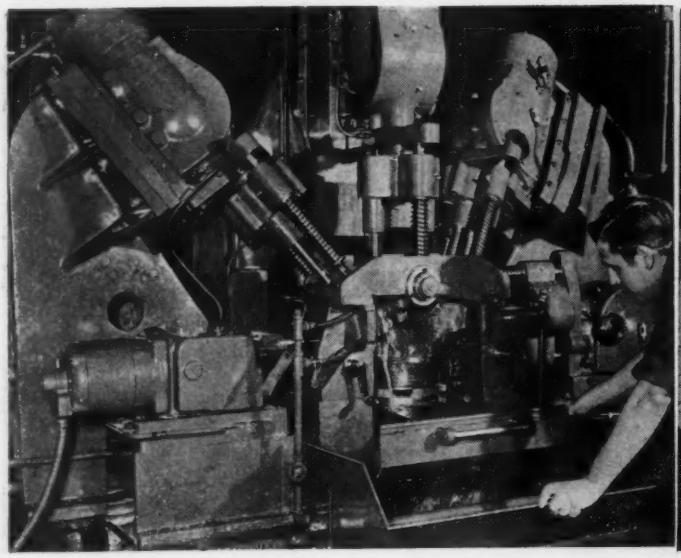

Fig. 5. Three special machines, each with five Kingsbury heads, are provided for drilling, burring, and tapping holes at five different angles. Each machine has twelve tools and a box fixture on a slide which is pulled out for loading and unloading cylinder heads.

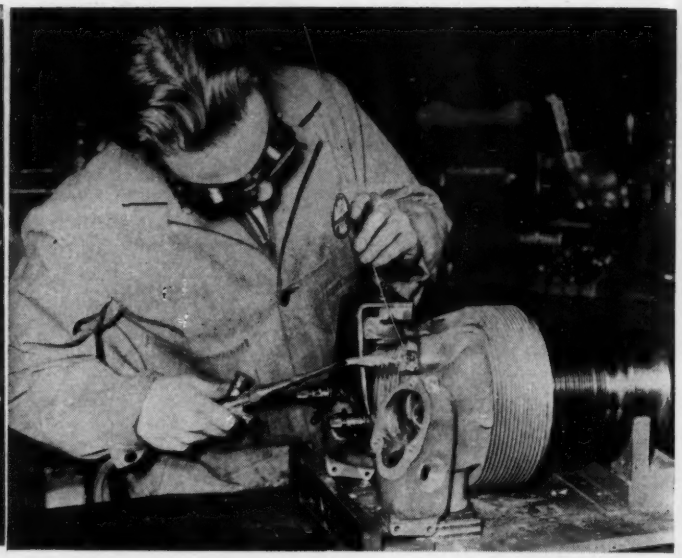

Fig. 6. Bench setup in which a copper oil scavenger manifold is silver brazed into couplings that have been screwed into rocker boxes, while a clamp holds manifold in place. Later a clip is similarly brazed to center of manifold.

a horizontal axis to drill, ream, spotface, and tap push-rod holes. In this setup, certain tools have to be changed between cutting operations. Then heads are shifted to the first of three special machines, each equipped with five Kingsbury heads arranged at as many different angles around a central box fixture, as illustrated in Fig. 5. The fixtures include slides which are withdrawn for removing one piece and mounting the next. There are twelve tools in each machine, and they are advanced automatically when the piece is in place and the machine started.

In the first machine, twelve stud holes are drilled, in the second all the holes are burred, and in the third all are tapped. All threads in the head have to be Class 3 fits. This completes all precision machining done on the head prior to its assembly to the cylinder barrel, but the head goes first to a Doall saw, in which the locating stud used in foregoing operations is sawed off, and then to some 15 filing, burring, and polishing operations to remove burrs and to clean and polish various surfaces not already machined.

Most of this work is performed on benches and with hand tools. In other cases electric or air-driven tools are employed, some of them making use of flexible shafts between the driving motor and the tool. It is necessary that surfaces be smooth and free from scratches and burrs. But, except where any excessive roughness occurs, the faces of fins and some other areas are left with their natural cast finish. After the head has been assembled to the barrel, however, the exterior of the assembly is sand blasted and then is given a spray coating of molten aluminum.

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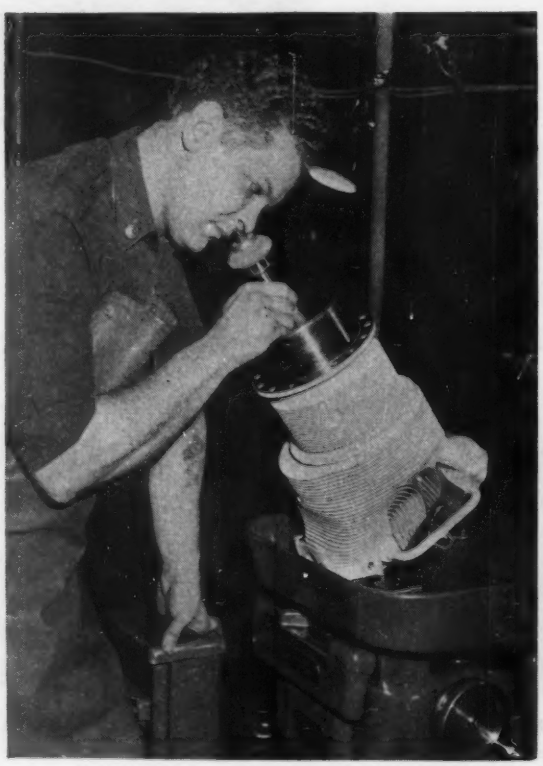
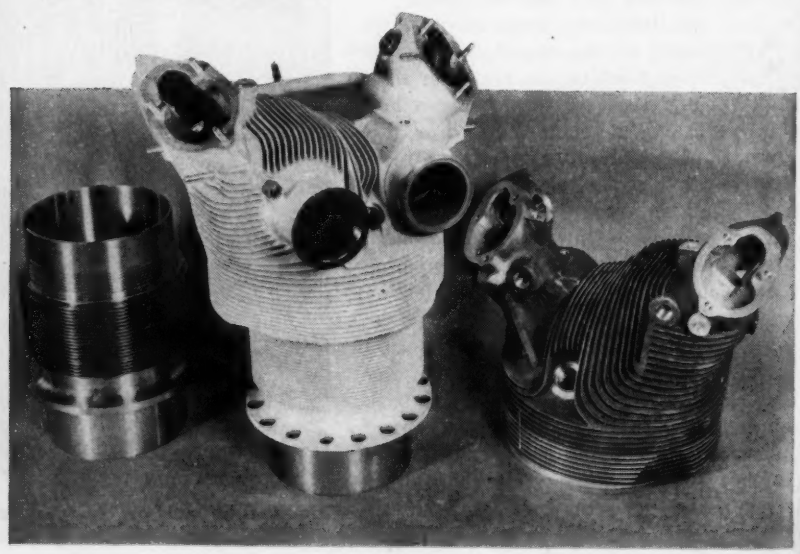
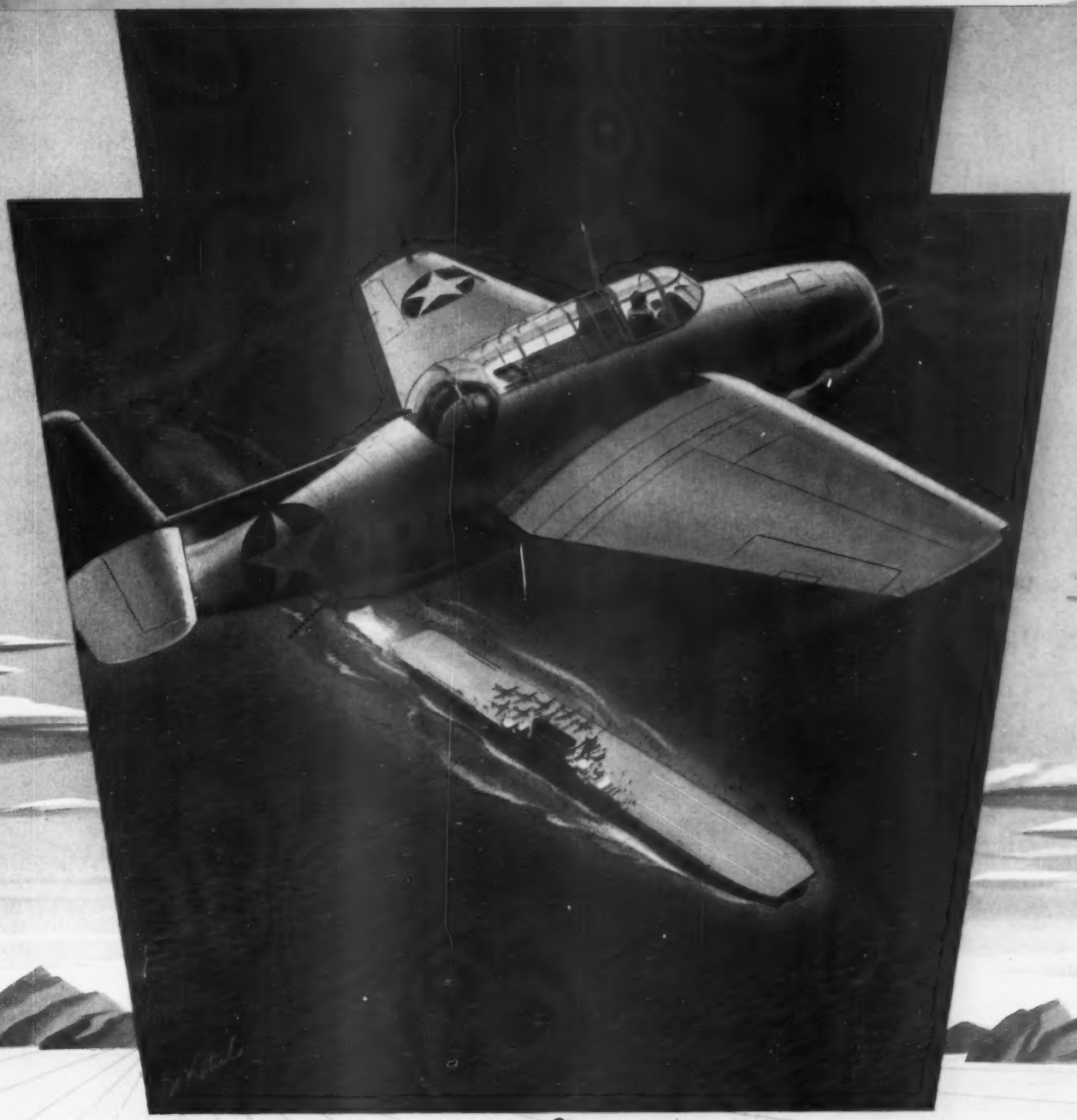


Fig. 7. Waddell machine in which exhaust valve seats are ground. Tool is inserted from above, after cylinder assembly has been clamped in position, and is given eccentric as well as rotary motion.

Fig. 8. Cylinder assembly as it appears when completed. At left is a machined cylinder barrel, at right a machined aluminum head. Several machining and other operations are performed after barrel, head, and some smaller parts are built into assembly.





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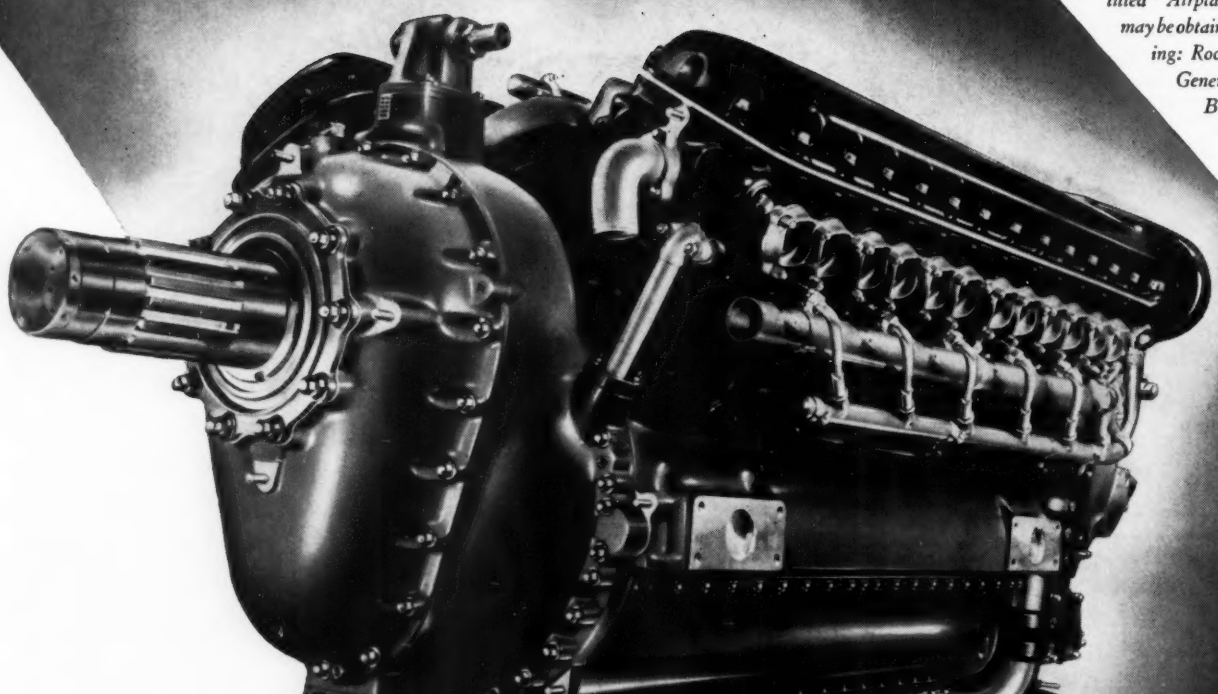

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New Process Simplifies Template Reproduction

Development of dimensionally stable film makes possible unusual time savings, eliminates need for highly skilled labor, and no darkroom equipment is necessary.

TEMPLATE REPRODUCTION JOBS which normally would require approximately 1,400 man-hours have now been produced in 300—without skilled labor or expensive equipment—through use of the new Transphoto Film reproduction process, pioneered by Fleetwings, Inc. With that saving of some 1,100 man-hours in the reproduction of 108 shop templates from 18 master layouts, the system today is being adopted by several major aircraft producers.

The film can be used in two different ways—either conventional photographic reproduction, or by chemical pickup (the most widely used) with accuracy within 0.015 on a 10 ft. length guaranteed. Most operators, however, keep within 0.007 or 0.008 in. on 10 ft.

The new film is a joint development of Peerless Photo Products, Inc., and the Goodyear Tire & Rubber Co., its base being a form of the latter's synthetic Pliofilm. In appearance, Transphoto Film is much like ordinary film, but it is dimensionally stable through all the reproduction process steps, and it does not require darkroom equipment.

In operation, the chemical-pickup

Transphoto film, which remains dimensionally stable whether wet or dry, here is cut to size. Accuracy to within 0.015 in. on 10 ft. length is guaranteed, but in practice accuracy is normally held to within 0.007 or 0.008 on that length. It is found that skilled labor is not necessary to maintain such standards.

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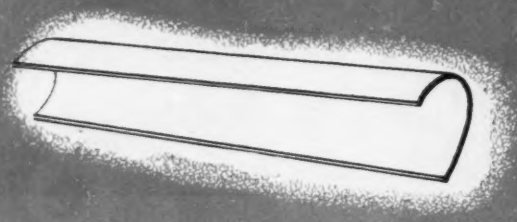

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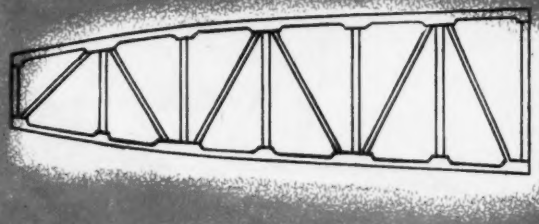

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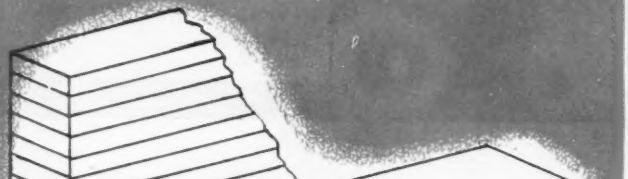

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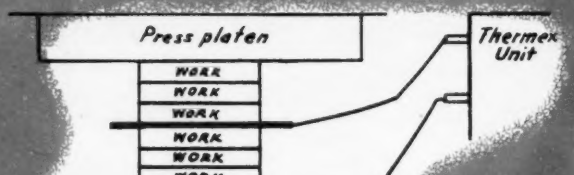

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(Left) Having been immersed for one minute in a "pickup" solution, film is placed emulsion side down on master layout and squeegeed into close contact with master layout. For smaller templates, ordinary rubber squeegee employed by window washers has proved entirely satisfactory. And for larger layouts, such as shown above, inexpensive kitchen floor brush is recommended.

process—which eliminates photographic exposure and development—consists of these steps:

First, the master layouts are scribed on sheets of metal which have previously been given a thin coat of zinc-chromate or other surface coat suitable for scribing. Plain zinc chromate has been adopted as standard at Fleetwings following considerable experimenting with paints, dyes, and shellacs.

Next, the Transphoto film is immersed for one minute in a special "pickup" solution, then placed—emulsion side down—on the master layout and squeegeed into close contact. For smaller templates, the ordinary window washer's squeegee can be used, but for large layouts an ordinary floor scrubbing brush is recommended.

Following a five minute contact with the layout, the film is processed through a hypo solution, rinse water, and a bleach, then immersed in the final transfer bath for 30 sec.

The film is then squeegeed onto the

(*Turn to page* 361)

Film (left) is left in contact with layout for five minutes, after which it is processed through a hypo solution, rinse water, and bleach, followed by a 30 sec. immersion in a final transfer bath. In final step, (right) film is squeegeed on metal sheet which is to become duplicate or shop template. During this contact, a positive image of original layout is transferred to duplicate sheet in form of dark lines formed by a silver deposit, for final transfer is actually a silver plating process.

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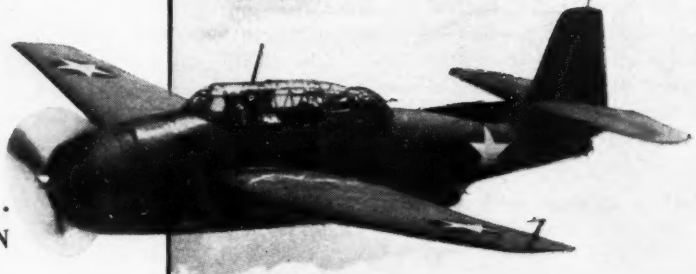
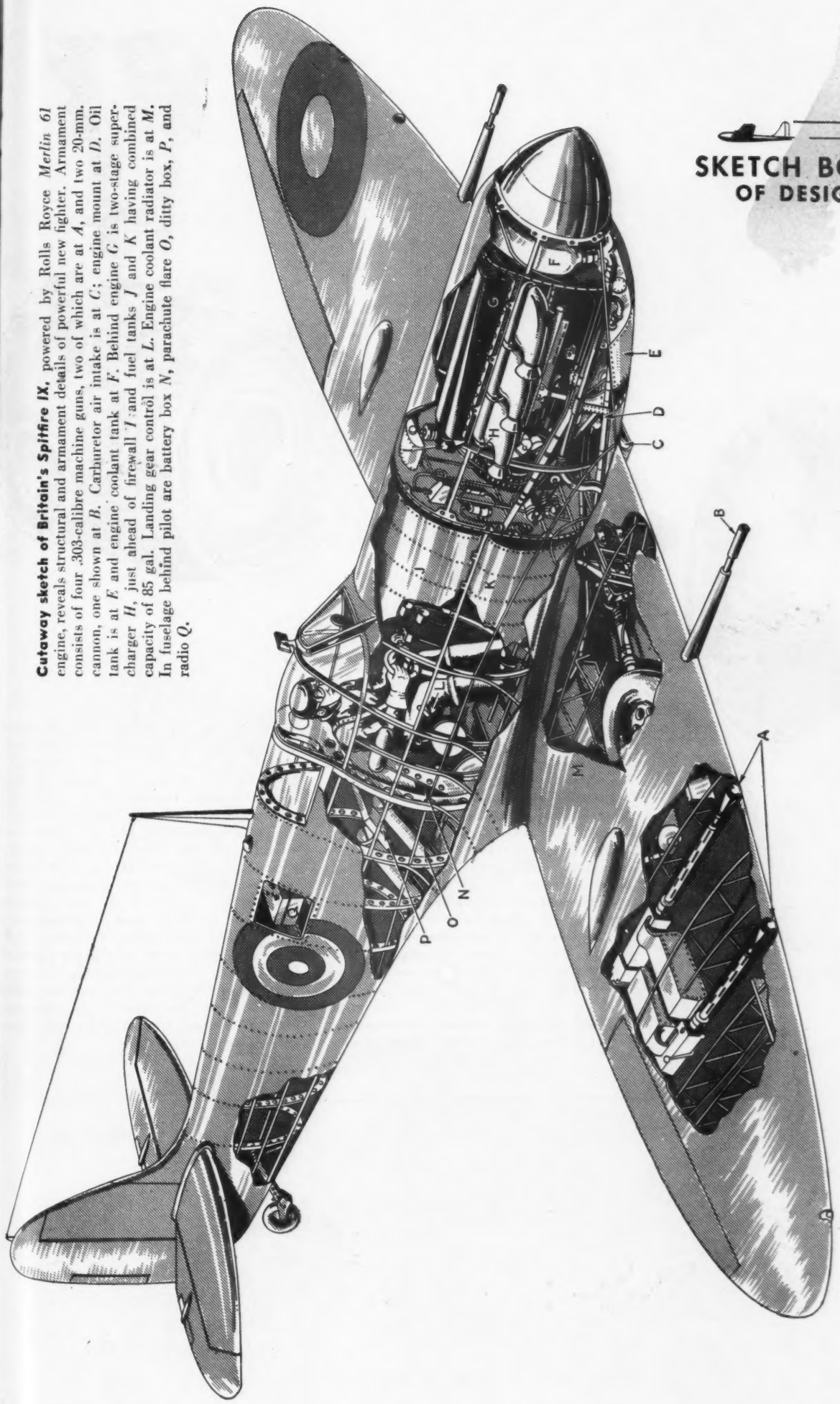


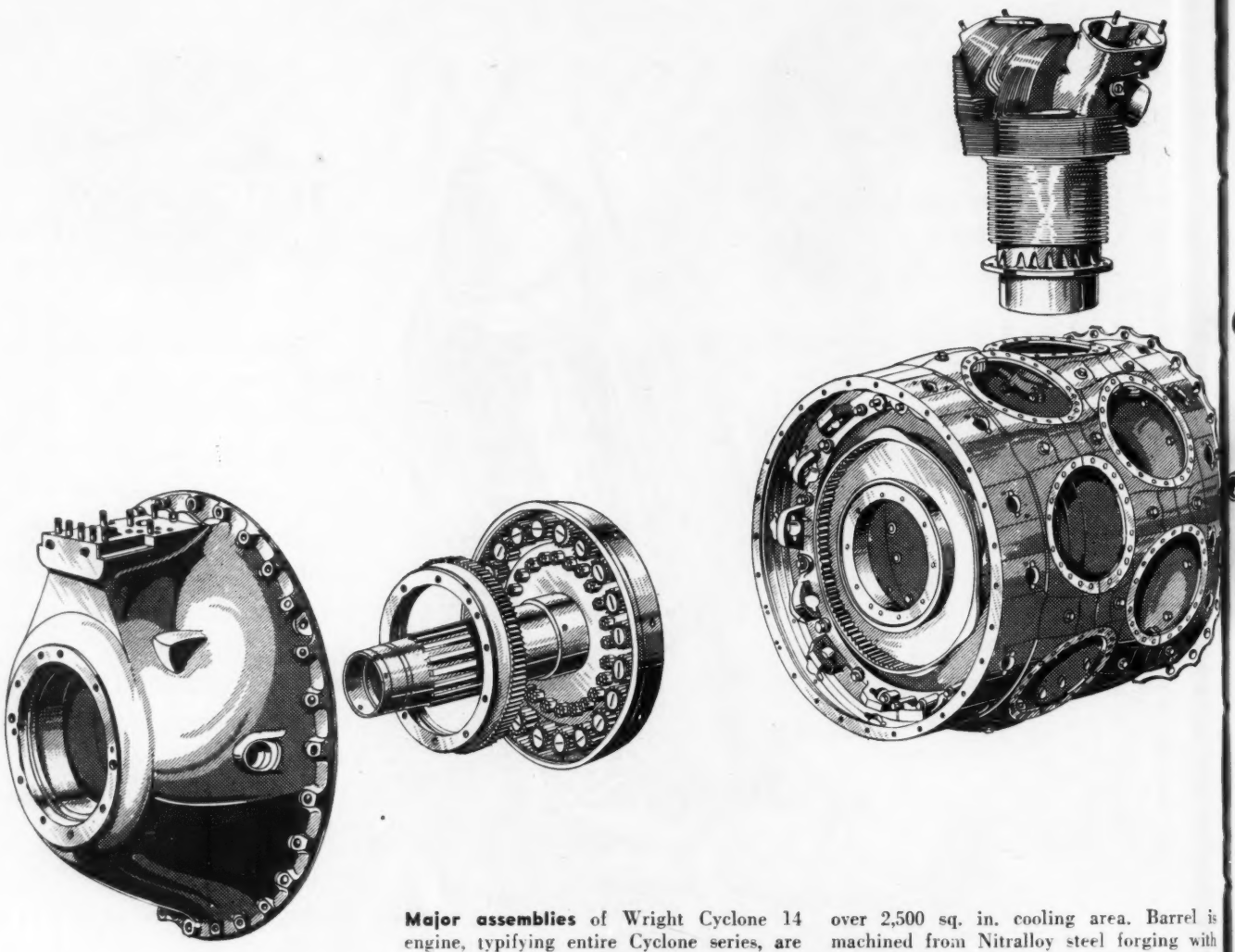
Official U. S. Navy Photograph

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

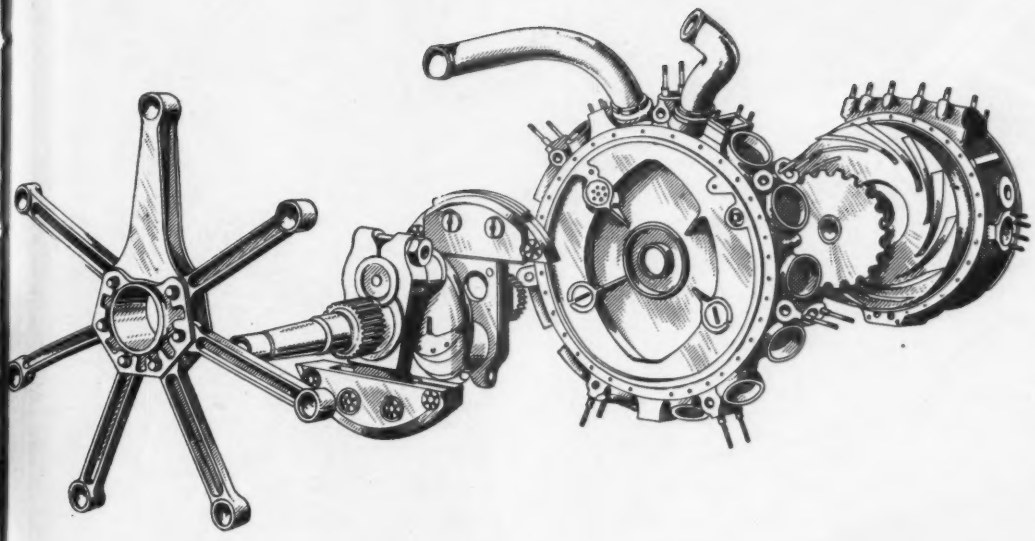
SKETCH BOOK OF DESIGN DETAIL

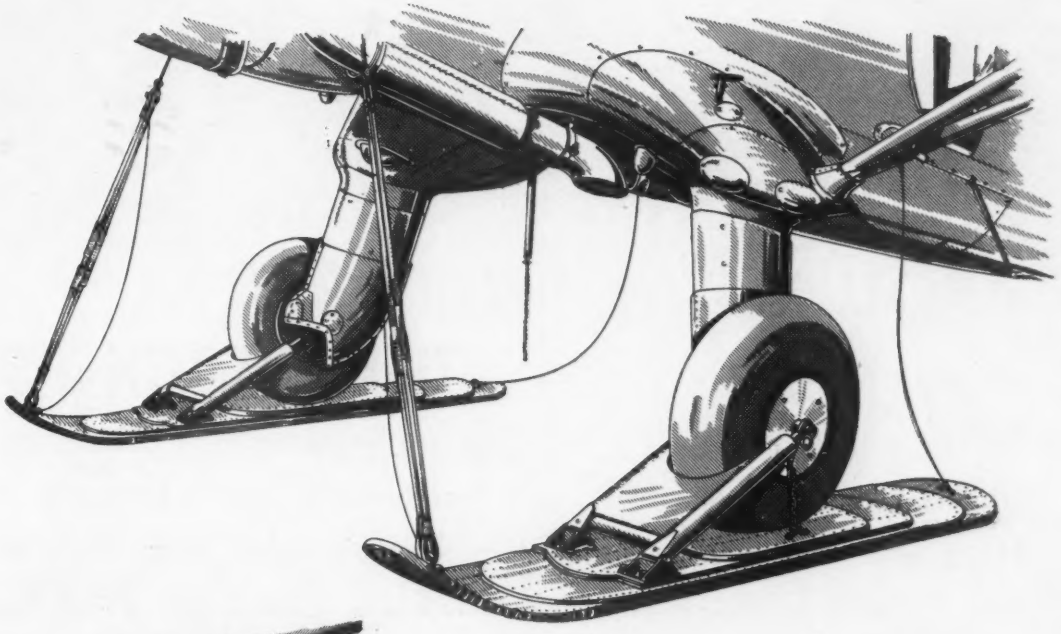


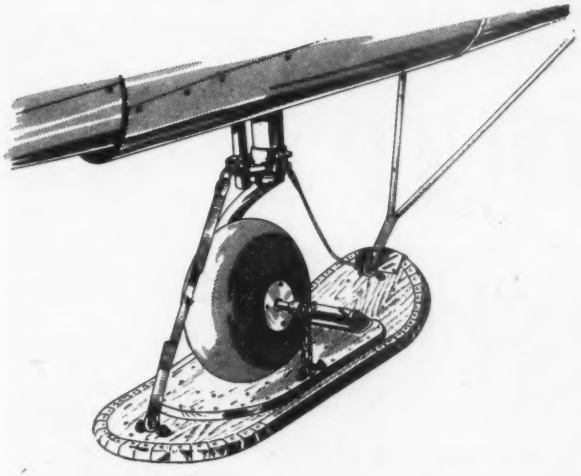
Cutaway sketch of Britain's *Spitfire IX*, powered by Rolls Royce *Merlin 61* engine, reveals structural and armament details of powerful new fighter. Armament consists of four .303-calibre machine guns, two of which are at *A*, and two 20-mm. cannon, one shown at *B*. Carburetor air intake is at *C*; engine mount at *D*. Oil tank is at *E* and engine coolant tank at *F*. Behind engine *G* is two-stage supercharger *H*, just ahead of firewall *J* and fuel tanks *J* and *K* having combined capacity of 85 gal. Landing gear control is at *L*. Engine coolant radiator is at *M*. In fuselage behind pilot are battery box *N*, parachute flare *O*, ditty box, *P*, and radio *Q*.



Major assemblies of Wright Cyclone 14 engine, typifying entire Cyclone series, are shown here, beginning with nose section at left. Next is planetary system of reduction gearing, consisting of driving gear splined to front section of crankshaft, stationary gear secured to nose section, and series of pinion gears carried on propeller shaft. For .666 ratio, inner end of propeller shaft carries six radial arms, on each of which a pinion is mounted. For all other ratios, propeller shaft terminates in flange to which is bolted a carrier ring having 20 trunnions acting as journals for pinion gears. Crankcase is high-tensile forged steel, three sections of which (two for Cyclone 9) are joined by short bolts through internal lugs. To insure accurate alignment, sections are assembled for final machining. Cylinder head provides over 2,500 sq. in. cooling area. Barrel is machined from Nitralloy steel forging with internal walls nitrided to obtain unusually hard surface. Piston is machined from aluminum alloy forging, with cooling fins milled into inside walls. Master rod is of one piece construction, with articulated rods to other cylinders attached to it by knuckle pins. Cyclone 9 crankshaft is built in two sections; the 14 and 18 comprising three. Front section of the 9 includes crankpin, crankcheck to which front counterweight is attached, and forward shaft extension. Front and rear sections of all models are machined from chrome nickel molybdenum steel forgings; center sections from chrome nickel steel forgings. Assemblies at extreme right are supercharger front housing and supercharger and accessory drive section.







Main landing gear and tail wheel-ski landing gear combinations of the Canadian-built Noorduyn *Norseman* are designed so that it requires but 20 min. to change from one to the other. Skis themselves built up of wood, with metal covering. (For details on UC-64 version now being delivered to American Air Forces, see AVIATION, June, page 241.)

AROUND THE WORLD ...THEN BACK TO YOU

When peace comes . . . — Aeroquip, war-tested in aircraft operations from the Arctic to the Sahara to the Solomons, will return from war work and open new horizons for industrial and chemical uses of liquid-carrying lines. Plan ahead — write now.

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Inexperience, ineptness, fatigue, ill-health, inattention, indifference—all are possible bugaboos when using fixed gages on extremely close tolerance work (i. e., checking to "tenths").

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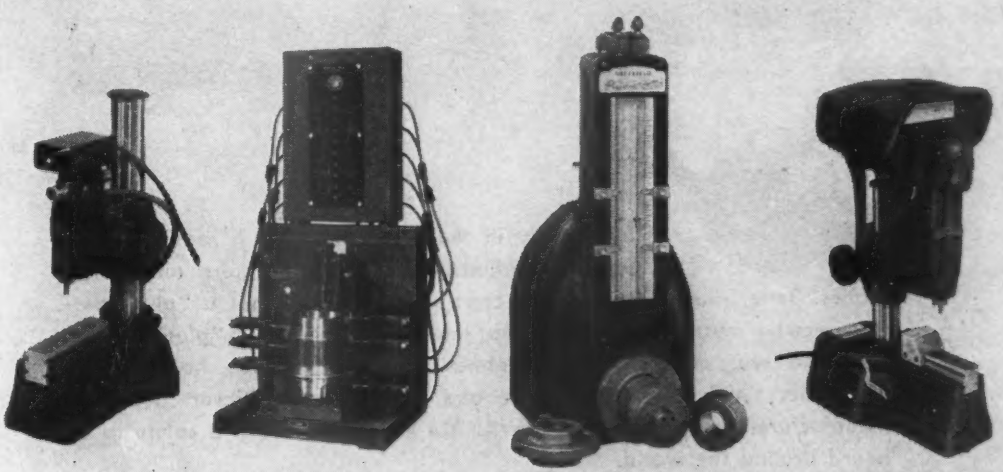

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For Sky Control...

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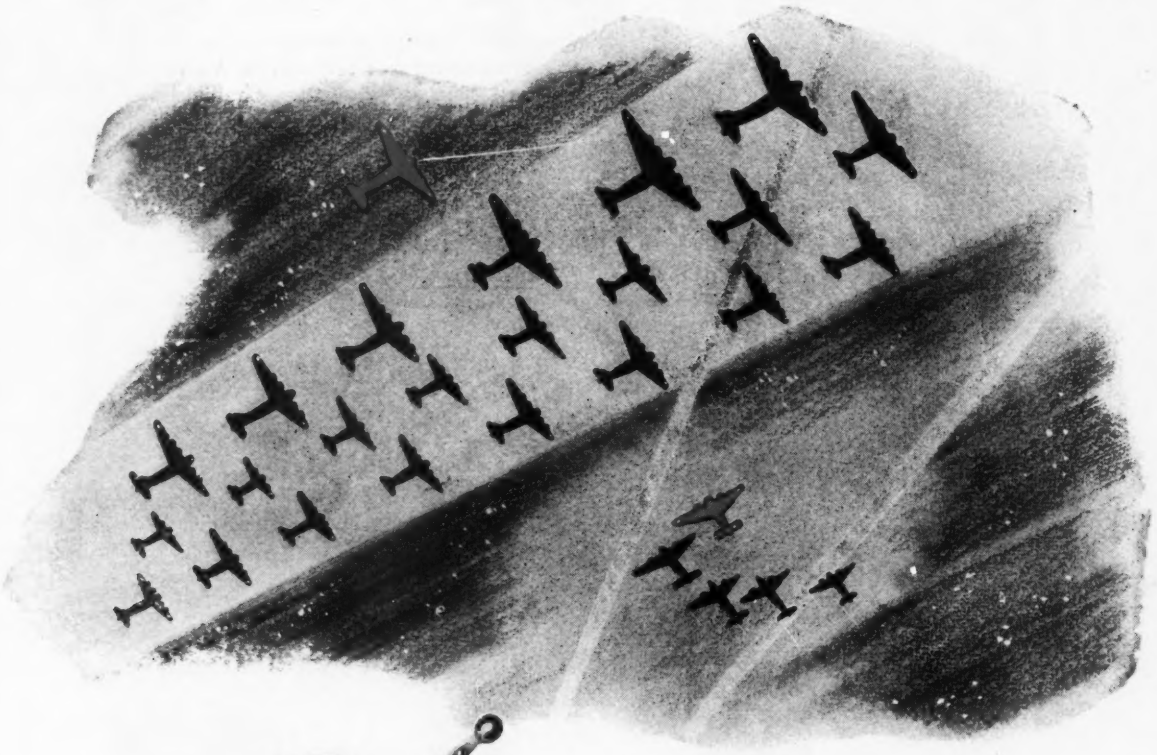

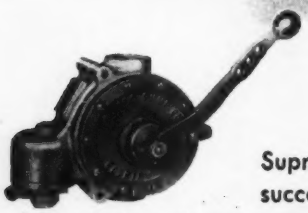

Supremacy in the air is the No. 1 requisite to a successful offensive. That means more and better planes. Better planes means finer component parts. To get a "plus" performance we must manufacture pumps and other parts with a "plus" quality.

In this war, that "plus" performance is essential to holding that supremacy. With resolute courage and perseverance aircraft accessory manufacturers have shown their WILL TO WIN. They merit a salute to be heard around the world.

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BUY WAR BONDS ★

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Commercial Synthetic Rubber Types

Buna-S: The word buna was first used in Germany. "Bu" is the first syllable of butadiene. "Na" comes from natrium, the classical name of sodium, which was originally used as a catalyst in the polymerization of butadiene. The letter S stands for styrene. Buna-S is a co-polymer produced by the polymerization of approximately three parts of butadiene with one part of styrene.

Butadiene is a gas at normal temperature (above —5 deg. C or 23 deg. F.).

Buna-S is the synthetic most similar to natural rubber in processing and performance characteristics. It may be vulcanized with sulphur and rubber accelerators and cured to hard rubber. Its resistance to atmospheric deterioration is comparable to that of rubber, in fact is slightly higher. It may be used to replace rubber in most applications, though it must be remembered that comparatively little has been made in this country and experience in the compounding and in use of buna-S has been limited.

To bring out its best physical properties, buna-S must be compounded with a black pigment. Properties of the pure gum stock are inferior. Inclusion of carbon black means that all buna-S products will be black.

Plants for production of buna-S are in operation and more are being built to be operated for the government by the U. S. Rubber Co., Firestone, Goodrich, and Goodyear.

Buna-N: The buna-N synthetic rubbers are co-polymers of butadiene and acrylonitrile, or vinyl-cyanide. The N refers to the nitrile or cyanide radical.

Buna-N types include the following: *Perbunan,* by Standard Oil Co. (New Jersey) and the Firestone Tire and Rubber Co.; *Hycar,* by Hycar Chemical Co., owned by Phillips Petroleum Co., and the B. F. Goodrich Co.; *Chemigum,* by Goodyear Tire and Rubber Co.; *Thiokol RD* (but not the other *Thiokols*), by Thiokol Corp., associated with the Dow Chemical Co.

Although the buna-N's are similar to rubber in being vulcanized with sulphur and rubber accelerators and curable to hard rubber, they differ from rubber in other processing characteristics and in some operations are more difficult to handle. They have good oil resistance, but their resistance to light is inferior.

The buna-N types have been produced in this country for many years and quantitatively have been next in importance to the neoprenes. Supply is still limited, however.

Buna-N types have been used in oil and gasoline hose, tank linings, packings, gaskets, printers' blankets, rubber covered rolls, and in many other applications where resistance to oil is important.

Neoprene: This product, a co-polymer of chloroprene, was introduced by the du Pont Co. in 1932 under the name Duprene. It was the first commercially successful synthetic rubber.

Neoprene is a good general-purpose rubber. It has good resistance to chemicals and oils and excellent resistance to heat, air, and light, in fact, it has better light resistance than any other rubber. An important quality of neoprene is its flame resistance, and for this reason it is used as an outer sheath for electrical insulation, although its electrical properties are lower than those of natural rubber.

However, neoprene is less like rubber in some characteristics than the bunas and butyl. It cannot be broken down or plasticized by milling without the use of plasticizers, because so much heat would be generated that the stock would stiffen up or cure up on the rolls. It does not require sulphur for vulcanization and cannot be cured to hard rubber.

Even though the du Pont Co. has greatly expanded its manufacturing facilities, neoprene is still under strictest rationing and may be secured only for military applications under the allocation by WPB.

Neoprene has been used in oil resistant hose, belting, gaskets, sheet goods, tubes, tape, fabrics, footwear, latex tank crash padding, barrage balloons, fuel cells, cements, truck and bus tires, and inner tubes.

Butyl Rubber: Called the "ace in the hole" in our synthetic program, butyl rubber was developed by Standard Oil of New Jersey. *Flexon,* a modification of this type, is called "bathtub butyl" because it can be made with comparatively simple equipment.

According to present indications, butyl rubber can be produced quickly at low cost from abundant materials and can be used to replace natural rubber in many applications, although so far it has not exhibited the qualities of buna-S.

Butyl rubber is a polymer of isobutylene and small quantities of other diolefines, such as isoprene or butadiene. Isobutylene is a gas at ordinary pressures and at temperatures above —6 deg. C. (21.2 deg. F.) It is produced in quantity as a byproduct in petroleum cracking.

Processing characteristics of butyl rubber are comparable to those of natural rubber, but it has less adhesion and a much longer curing time. Butyl may be plasticized by milling with plasticizers and vulcanized with sulphur and rubber chemicals of the ultra-accelerator type.

MAKE THEM MORE AND MORE AUTOMATIC

★ ★ TO INCREASE THEIR FIGHTING POWER

White-Rodgers automatic temperature modulation equipment relieves pilots for greater concentration on fighting power by providing completely automatic control of:

1. **Engine cowl flaps (both air and liquid cooled).**
2. **Oil cooler shutters or flaps.**
3. **Cabin temperature (both super-charged and normal).**
4. **Carburetor air temperature.**

Upon request, engineering data will be furnished to manufacturers requiring controls for the above or other temperature control applications.

WHITE-RODGERS ELECTRIC COMPANY

SAINT LOUIS MISSOURI

"THE CORSAIR"
OFFICIAL U. S. NAVY
PHOTOGRAPH

Its general resistance to deterioration is good, its resistance to oxygen and acid very good, but its physical properties are inferior to those of natural rubber.

The impermeability of butyl rubber to gases is excellent, and partly because of this butyl is resistant to mustard gas and is one of the few materials resistant to Lewisite.

Butyl may be used to advantage in applications where resistance to chemicals and oxidation is more important than such properties as tensile strength and resistance to cold flow.

The Thiokols: Types *A*, *B*, and *FA* of thiokol differ in processing and performance characteristics from natural rubber and from other commercial synthetic rubbers. (Thiokol RD must not be confused with this group.)

Generally speaking, the thiokols have excellent resistance to deterioration and better resistance to aromatic hydrocarbons than rubber or other synthetic rubbers. They do not possess as good physical properties as natural rubber or other synthetics, particularly as regards resilience, tensile strength, and resistance to cold flow, abrasion, and extremes of temperature.

Where resistance to deterioration is more important than physical properties, as in paint spray and solvent hose, oil resistant hose, certain packings and gaskets, printers' blankets, and tank linings, the thiokols have been successfully substituted for natural rubber.

Comparative Properties of Synthetic Rubber Types

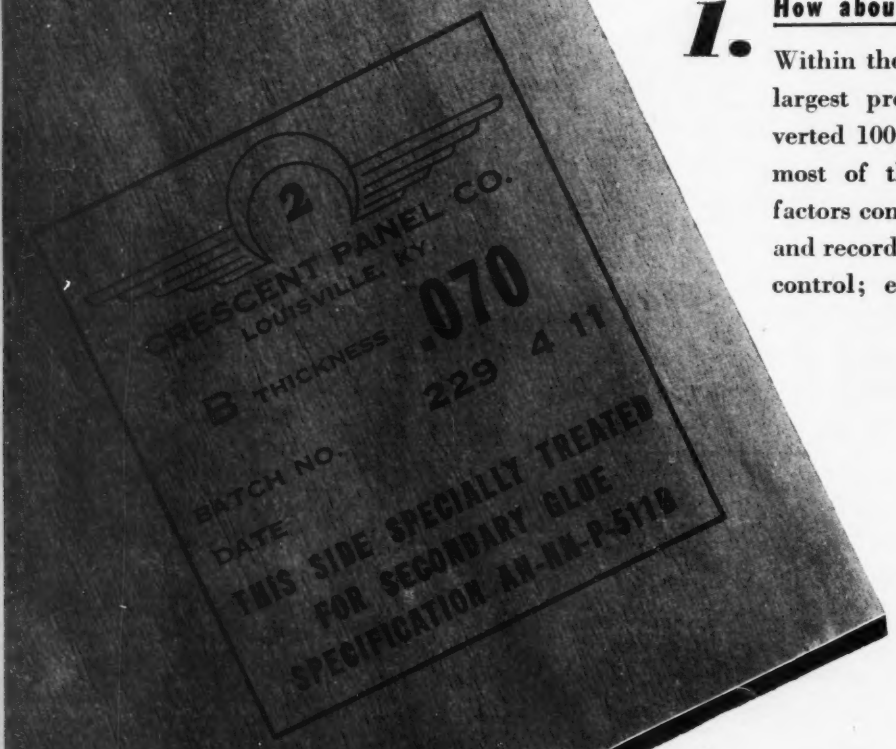
Properties Important in Processing:	Natural Rubber	Buna S Type	Buna N Type	Neoprene Types	Butyl Type	Thiokol Polysulfide Types
Form in which available:	Latex and Solid Forms	Latex and Solid Forms	Latex and Solid Forms	Latex and Solid Forms	Solid Form	Dispersion, Solid & Powder Forms
Breakdown	Very Good	Good	Fair	Good—V.G.	None	Slow
Plasticity range after breakdown	High-Low	High-Low	High-Medium	High-Low	Medium	High-Low
Building tack and cohesion	Excellent	Fair	Fair	Very Good	Good	Fair-Good
Vulcanizability	Very Good	Very Good	Very Good	Very Good	Fair-Good	Fair
General processability	Very Good	Good	Fair	Good	Fair	Fair
Properties Important in Application:						
Physical Properties						
Extensibility	Excellent	Good	Good	Excellent	Excellent	Good
Resilience	Excellent	Good	Fair-Good	Very Good	Low	Good
Tensile	Excellent	Fair-Good	Good	Very Good	Good	Fair
Electrical properties	Excellent	Excellent	Fair	Fair	Excellent	Fair
Impermeability to gases	Good	Good	Good	Very Good	Excellent	Excellent
Impermeability to water	Good-Very Good	Fair-Good	Fair-Good	Fair-Good	Very Good	Very Good
Resistance to: Plastic flow	Very Good	Good	Good	Good	Fair-Good	Low
Abrasion	Very Good	Good-Very Good	Good-Very Good	Very Good	Fair	Low
Tear	Very Good	Fair-Good	Fair-Good	Good	Fair-V.G.	Fair-Good
Heat	Good	Fair-Very Good	Fair-Very Good	Very Good	Fair	Low
Cold	Very Good	Very Good	Fair-Good	Fair-V.G.	Good	Fair-Good
Chemical Properties						
Resistance to: Air	Fair	Good	Good	Excellent	Excellent	Excellent
Ozone	Inadequate	Inadequate	Fair	Excellent	Excellent	Excellent
Light	Fair	Fair	Low	Excellent	Excellent	Excellent
Petroleum	Low	Low	Excellent	Good	Low	Excellent
Aromatic oils	Inadequate	Inadequate	Fair	Low	Inadequate	Excellent

Note This chart covers only generalized types of synthetic rubber. The information given should not be used in specifying materials. Individual properties may be developed by special compounding, as suggested by the ranges shown in the table. Definite recommendations as to type should be left to the manufacturer. Table compiled Mar. 1943.

Courtesy United States Rubber Co.

Ask these 6 questions before

Practical pointers to help you compare sources for aircraft plywood—and to improve the service and quality you may be getting on this important war material!



1. How about the company's ability to produce?

Within the past year Crescent has become one of the largest producers of aircraft plywood, and is converted 100% to this product. Today Crescent serves most of the large users in the industry. Several factors contribute to the enviable production capacity and record that makes this possible: strict production control; excellent equipment of the most modern types; a shorter manufacturing cycle; exclusive and original plant methods; veteran supervisors and ample skilled labor; systematic line production flow; "on-the-ground" integration of management, engineering and operating departments; close familiarity and cooperation with prime and sub-contractors and their problems.

This insignia appears on all Crescent aircraft plywood

Crescent

LEADING MANUFACTURERS OF *Engineered*

you buy Aircraft Plywood!

2. What is the manufacturer's background?

Crescent Panel Company is one of the oldest plywood producers—in fact, one of the *two* companies that made *aircraft* plywood in the first World War. Crescent was the *first* American organization to see the possibilities of Sheet Phenolic Resin and *brought it to this country.* This company has worked with sheet phenolic for the past ten years—and gained invaluable "know how" that cannot be secured over-night.

3. How thorough is the company's quality control?

Crescent has had the *highest classification rating* on quality control for the past year. The inspection methods that account for this keep difficulties in the field extremely negligible. At Crescent, each sheet of veneer is individually inspected prior to the first operation. There are four other inspection points before gluing. After gluing, each panel is inspected twice. Test samples are constantly being run—approximately five times as many as specifications require. In addition to these steps, a resident Army Air Force inspector is on hand to make an additional inspection whenever a customer requests it.

4. Does the supplier have control over raw materials?

One of the country's larger producers of aircraft veneer is directly affiliated with Crescent Panel Company, and contributes its entire output to Crescent plywood. In addition, Crescent is located in the heart of the veneer country. These factors are very advantageous in assuring a constant flow of raw material, and in eliminating costly transportation delays.

5. How flexible are the company's operations?

Crescent is *big enough* to handle very large orders, yet *small enough* to give efficient service on smaller orders or special requirements. The organization is compact and accustomed to making rapid decisions and moving quickly. The sales, executive, engineering and plant offices are at the factory. Crescent can, and does, move fast to eliminate any possibility of failure or delay on any customer's production line. This advantage of flexibility is vitally important to users of Crescent plywood when emergencies occur.

6. How about the producer's ability to deliver?

After all, your main interest is, "Can I get the *type* of plywood I want *when* I want it?" . . . The reply is "YES", at Crescent. The answers to the preceding questions here help to explain why Crescent *has the ability to deliver.* Perhaps they will give you a yardstick for evaluating the present service and quality you get on plywood . . . We'll welcome an opportunity to help you at any time—whether you send an order or just want technical advice!

Crescent Panel Company (Incorporated), Louisville, Ky. Completely finished aircraft parts are fabricated by an affiliated company: INDIANA VENEER & PANEL CO., NEW ALBANY, IND.

Panel Company

AIRCRAFT PLYWOOD FOR OVER 23 YEARS

Review of Patents

By A. HARRY CROWELL,
Registered Patent Lawyer

FOLLOWING are digests of some of the more significant recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish readers information, without charge or obligation, on approximate cost and procedure in applying for patents and trademark registrations. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York. Printed copies of any of the patents listed below are obtainable at 10c each directly from U. S. Patent Office, Washington.

Flight Training Device. Some of conditions of actual flying are simulated through stationary mechanisms. A shadow of nose of a plane is cast upon an endless translucent web decorated with a landscape scene visible from student's seat. Proper operation of controls makes scene progress as in normal flight.—2,312,370, filed Jan. 23, '42, issued Mar. 2, '43, C. W. Soule, assignor of one-third to O. Ramsdell.

Aileron differs from standard type by having either a doped fabric or metallic skin covering. It embodies metal and is designed and constructed with proper balance about its hinge line without use of any appreciable amount of ballast.—2,312,540, filed June 6, '41, issued Mar. 2, '43, J. G. Hazard and A. E. Arslan, assignors to Vultee Aircraft.

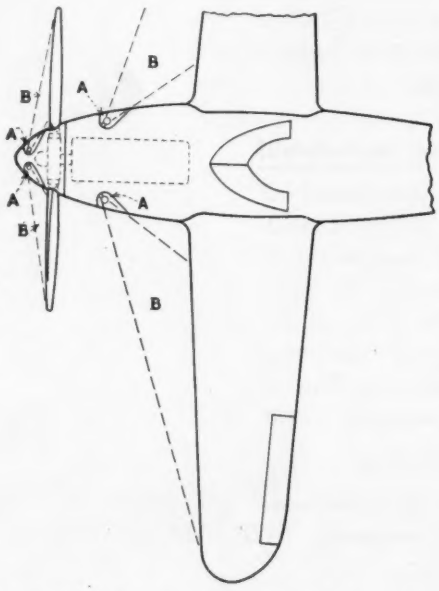
Tail Wheel Structure is offered as improvement in mechanism for automatically self-centering tail wheels. Essentially, self-centering mechanism consists of a crank connected to upright swivel shaft of wheel and a lever connected to crank by a pivot making a fulcrum. A spring moves lever into position where it centers wheel when crank is turned.—2,312,553, filed Aug. 27, '41, issued Mar. 2, '43, J. M. Hudson, assignor to Vultee Aircraft.

Airfoil Construction has all parts fully accessible for riveting or spot welding so that final assembly can be accomplished quickly and easily. Entire structure is reported strong, rigid, and light. Basis of assembly is a spar formed with all elements intended for attachment of other parts. Projecting rearward, some of these elements extend vertically and others horizontally. With these attaching elements, entire spar is formed in one piece. Clips are unnecessary.—2,312,603, filed Aug. 18, '41, issued Mar. 2, '43, F. Terdina, Jr., assignor to Boeing Aircraft Co.

Aerial Delivery Unit for quick release, specifically a container for use in conjunction with parachutes for safe dropping of rifles, machine guns, or other equipment, comprises a middle section with two telescoping end caps and a parachute pack attached to one of the end caps. It may be used by or for government royalty free. —2,314,881, filed Jan. 8, 1942, issued Mar. 30, 1943, P. F. Helmick.

New Fuel System includes time-delayed selector valves and has a mechanism wherein motor for selector valve operation may be normally operated at high speed from one position to the next, thereby minimizing period of time between successive selector valve positions. Unit is designed to provide a delay after port registration position has been attained during which time-period mechanism, responsive to pressure of fuel from pump, brings another cycle of operation of selector valve immediately upon a call for such. It may be used by or for government royalty free. —2,314,899, filed Aug. 13, 1940, issued Mar. 30, 1943, D. Samiran.

Automatic Fuel System. Featuring automatic safety switches, this system is designed so the contents of a plurality of fuel containers may be automatically connected in predetermined order to a source of fuel consumption, such as an airplane engine or the like. Automatic system is operable only when there is a normal pressure in oiling system of engine. It may be made and used by or for government royalty free.—2,314,900, filed Oct. 8, 1940, issued Mar. 30, 1943, D. Samiran.



Infra-Red De-Icer employs four lamps *A*, embedded in hub and nose section, which emit infra-red rays through lenses and covers composed of non-absorbent sylvin, fluorite, quartz, and special glass. Resulting radiant heat along propellor blades and wing leading edges (area *B*) is reported by the inventor, James D. Altemus, to keep them "substantially above the freezing point (32 deg. F.) even though the plane is travelling at hgh speeds and high altitudes."—2,317,019, filed Jan. 27, '41, issued Apr. 20, '43.

Multipurpose Parachute Delivery Container comprises a parachute and container for dropping articles or supplies from aircraft to ground without undue risk. Unit, particularly suitable for delivering material for which there is not an immediate need, such as food cans, ammunition cans, etc., may be made and used by or for government royalty free.—2,314,914, filed Apr. 8, 1942, issued Mar. 30, 1943, H. Wilson and W. P. Yarborough.

Airplane for observation or photographic work has fuselage designed to afford observer and pilot unobstructed vision through substantially all portions of craft. It embodies framework of geodetic design together with flexible transparent plates across spaces between diagonally extending members of framework.—2,314,949, filed July 12, 1940, issued Mar. 30, 1943, R. W. Palmer, assignor to Vultee Aircraft.

Ski Rigging For Aircraft has been devised so that it operates synchronously with wheel-rigging. As ski is moved upward it is simultaneously moved rearward; and when moved downward, into operative position, ski is also moved forward into original operative or running position.—2,315,098, filed Mar. 14, 1942, issued Mar. 30, 1943, H. A. Simpson and A. E. Larsen, assignors to Machine and Tool Designing Co.

Control Apparatus for Aircraft. Device comprises a power drive for aircraft empennage surfaces designed to reduce vibrations. Rudders and/or flaps are driven by at least two electric motors. Power of each driving motor is transmitted by means of a motion checking gear.—2,315,110, filed Sept. 14, 1939, issued Mar. 30, 1943, Claude Dornier, vested in Alien Property Custodian.

Airplane Construction. Intended where transport of heavy loads is desired, structural methods makes use of entire floor space of fuselage allowing loading via doorway so positioned that floor space immediately adjacent is positioned quite close to ground. Purpose is for maximum stability and simple and safe loading and unloading. Upper and lower portions of rear extremity of fuselage are movable and together function as a door across entire width of fuselage.—2,314,117, filed Sept. 8, 1939, issued Mar. 30, 1943, F. Freytag, vested in Alien Property Custodian.

Propeller Blade Mounting comprises an improved bearing construction for rotatably securing a metal blade shank in a metal propeller hub. Bearing races are formed in hub and blade structure, with separate races for bearings eliminated.—2,315,574, filed Mar. 9, 1940, issued Apr. 6, 1943, J. E. Anderson, assignor to United Aircraft Corp.

(*Turn to page* 351)

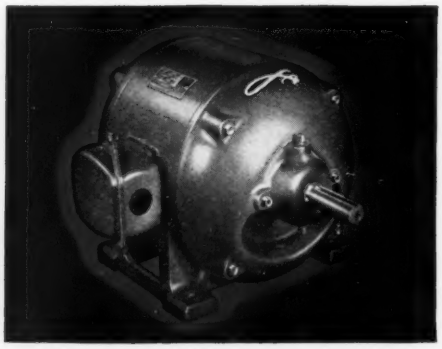
LOUIS ALLIS

A Size and Type Electric Motor for Every Industrial Requirement

THE LOUIS ALLIS CO., MILWAUKEE, WIS.

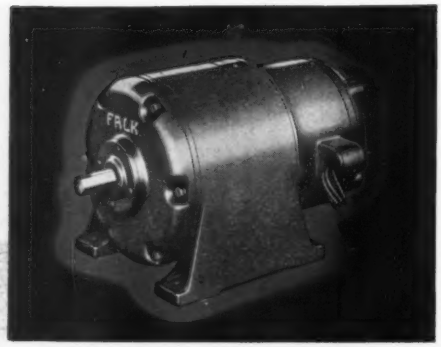
There is a Size and Type Louis Allis M

Standard open SQUIRREL CAGE polyphase motors are carefully engineered, precision built motors with rigid construction throughout and adequate insulation you can confidently apply to your toughest jobs.

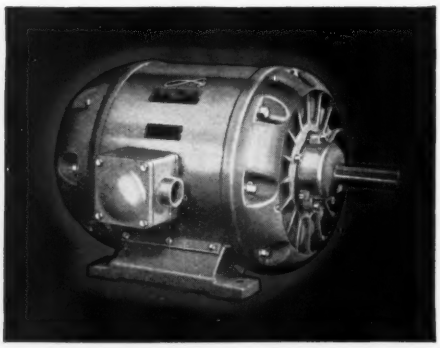


Louis Allis protected type squirrel cage motors (Type OG) are specially engineered and designed for applications requiring greater protection. Complete details sent upon request.

SPLASH-PROOF motor. Designed and built from the ground up as a real splash-proof motor—full protection against acid spills—splashing liquids—high humidity. Completely protected by cast iron housing.

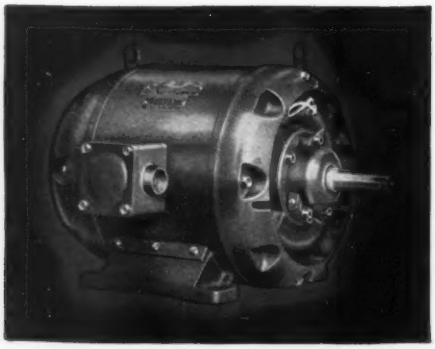


Louis Allis motors can be supplied with a very wide range of various types of GEAR REDUCERS — integral — all-motor — gear-head —vertical—right angle or parallel—the proper drive for every industrial application.



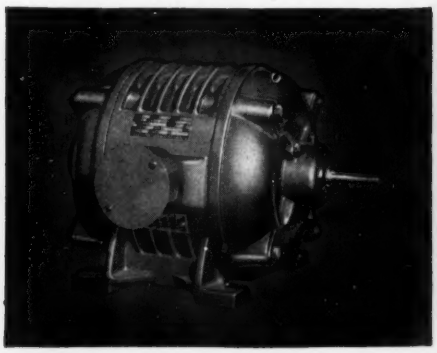
EXPLOSION-PROOF motor for use where gasoline and other petroleum products, lacquer solvents, and equally hazardous liquids are made, used or handled. Approved by underwriters'.

We have developed special RAPID REVERSING squirrel cage motors capable of as many as 100 reversals per minute continuously without overheating. If you have a product or manufacturing operation requiring rapid reversing action, we would be glad to outline more of the details and advantages of this unusual type motor for your particular problem. Your inquiry is solicited.



TOTALLY ENCLOSED FAN COOLED motors—for operation in atmospheres containing abrasive dust, corrosive fumes, dirt, oil combustible dust, and similar conditions such as are usually found in machine shops, foundries, chemical plants, grain elevators, coal pulverizing plants, etc.

Louis Allis totally-enclosed fan-cooled ARBOR TYPE motors are especially adaptable for applications where the available space for mounting is limited. These motors are available in a wide range of sizes and electrical characteristics. Complete information upon request.



A complete line of enclosed NON-VENTILATED motors is available in a wide range of mechanical and electrical characteristics. These motors are ruggedly constructed with solid cast iron housings to withstand severe treatment on difficult jobs.

No matter what your electric motor problem or requirement may be—we earnestly request your inquiry. Your needs will receive our most prompt and careful attention in every way.

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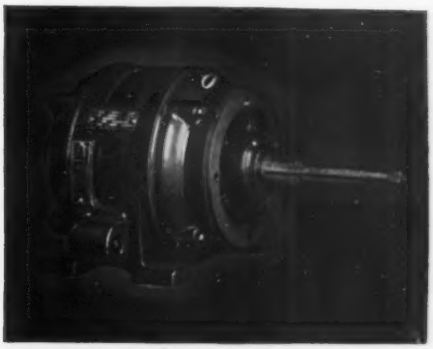
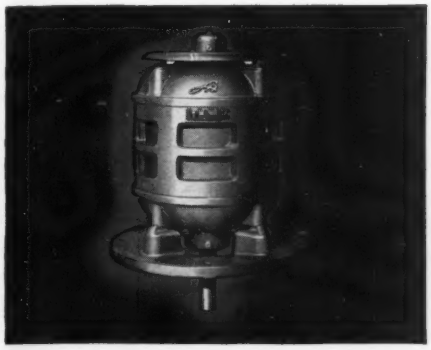
Allis Motor for Every Industrial Requirement . . .

If you have a product or manufacturing operation requiring 2, 3 or 4 speeds—write for copy of Bulletin 500-A fully describing Louis Allis MULTI-SPEED motors. Available in special electrical and mechanical modifications to meet specific requirements.

Louis Allis FLANGE-TYPE motors are available in an exceptionally large range of both electrical and mechanical features. End mounting of motor in this manner saves considerable space. We will gladly send more complete information regarding this type motor upon your request. Motor illustrated shows "B" type flange mounting.



Standardized flange mounting for mounting centrifugal pump directly on motor bearing bracket is shown in the above illustration. No matter what your "direct mounting problem" is we invite your inquiry.



Louis Allis VERTICAL motors can be supplied without base, with ring base, or with special base to meet specific requirements. Can be supplied with same electrical or mechanical modifications as horizontal motors. Additional information gladly sent upon request.

HOUSING TYPE SHAFTLESS motor developed for built-in motor drives on machine tools and special machinery. Furnished without shafts, bearing brackets or bearings—attached as an integral part of the driven machine. Available in all types of electrical modifications. Recommendation for your specific application gladly sent upon request.

The widespread experience of our engineering staff will be cheerfully placed at your disposal to assist in powering your product with these compact efficient SHAFTLESS motors. Available in wide range of sizes and electrical modifications.

These WOUND ROTOR (slip ring) motors are ruggedly constructed throughout. A wide range of speed variations are obtainable with comparatively simple control. Available with mechanical modifications for every industrial requirement.

These FREQUENCY CONVERTERS are designed to deliver higher speeds than are obtainable with direct current motor drives operating on 25 or 60 cycle supply lines. Available in both two-bearing and four-bearing types.

Louis Allis D. C. GENERATORS are built in sizes ½ to 50 Kw. and are of the same general characteristics as our regular D. C. Motors. Standard speed ratings are made the same as for induction motors. Complete details sent upon request.

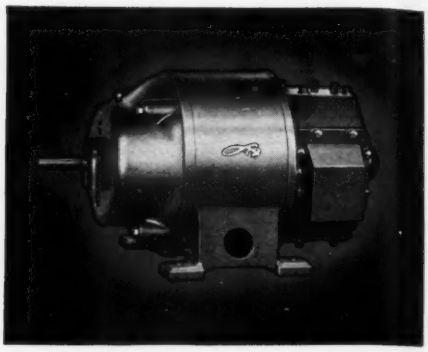
If you are planning a post war product that will require a special electric motor in its construction, our engineering development department will welcome the opportunity of working with you.

THE LOUIS ALLIS CO., MILWAUKEE, WIS.

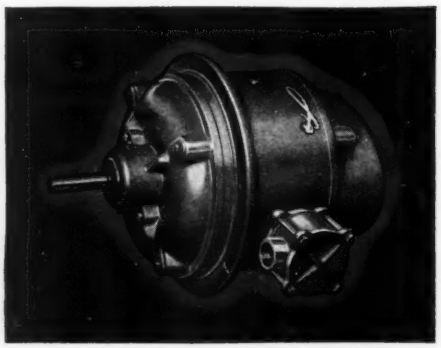
Specify by Name—Louis Allis

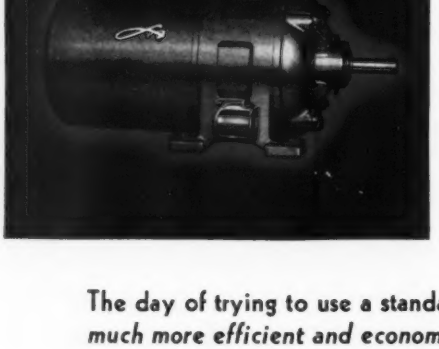
These DIRECT CURRENT motors are correctly engineered and precision built—available in a very wide range of both electrical and mechanical modifications. The extra rugged construction of these motors assures long life to dependable performance.

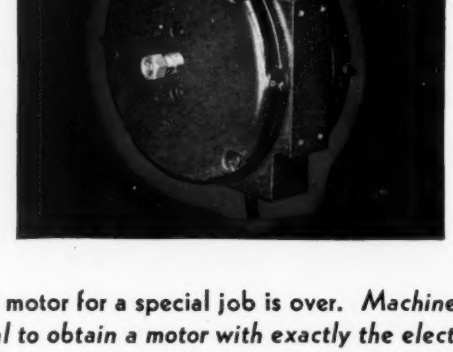
This PROTECTED D. C. motor has the same general construction features of the motor illustrated above. The specially designed protective end bell and armature coverings make this motor especially adaptable for use in coal mines, quarries, or where dropping particles may hit the motor.

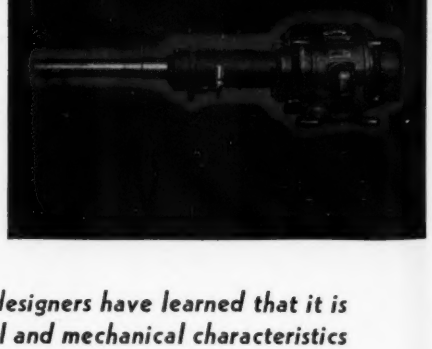


This D. C. SPLASH-PROOF motor is designed from the ground up as a real splash-proof motor and assures dependable trouble-free performance where the motor is subject to dripping and splashing liquids or where the motor is washed with a hose for sanitary reasons.







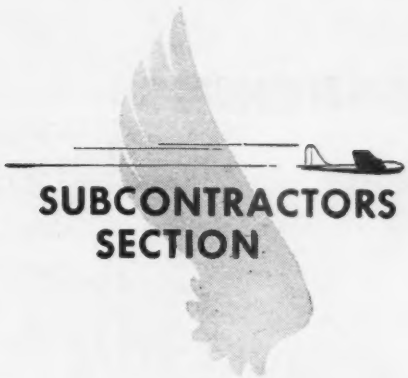


The day of trying to use a standard motor for a special job is over. *Machinery designers have learned that it is much more efficient and economical to obtain a motor with exactly the electrical and mechanical characteristics required to perform a specific job than it is to try to doctor up a standard shelf motor to do the job.*

Above are shown several typical examples of special motors recently built for some of our customer friends, the details of any of these will gladly be sent to you upon your request.

For over 40 years we have been developing special motors for special jobs—our engineering development department has a wealth of experience along this line—it is at your disposal. No matter what your electric motor problem or requirement we sincerely believe that our engineering development department can serve you to your decided advantage. We solicit your inquiries.

THE LOUIS ALLIS CO., MILWAUKEE, WIS.



SUBCONTRACTORS SECTION

CMP Forms Facilitate Allotments Of Materials to Subcontractors

SUGGESTED FORMS for use by prime contractors in extending or decreasing allotments of controlled materials to their subcontractors have been issued by the Controlled Materials Plan Division of the War Production Board.

Form CMPL-150A may be used by all contractors making allotments to subcontractors producing Class A products, except in the case of allotments being made under programs of the Aircraft Resources Control Office (Aircraft Scheduling Unit). The form shows the authorized production schedule and the allotment of controlled materials to the subcontractors, together with the allotment number. It also shows the preference rating assigned for use in obtaining non-controlled materials to complete an authorized production schedule. Copies of this form will be available at Field Offices of WPB. However, the form may be reproduced by manufacturers desiring to use it in large quantities.

Forms CMPL-200A and 201A provide the instrument with which contractors may increase or decrease allotments to their subcontractors. Form CMPL-200 and 201, issued at the same time, are for use by claimant agencies and industry divisions in increasing or decreasing allotments. The four forms concerned with adjustments in allotments also provide a means for indicating revisions in authorized production schedules. The instructions for use of these forms make it clear that production schedules authorized through their use supersede all previous authorized production schedules for the products involved.

Plant Conversions Urged

Curtailment of some subcontractors' schedules due to changes in over-all armament requirements have, in many cases, brought additional opportunities for subcontracting in the aircraft field, according to recent WPB reports.

Since new production facilities are being built only where it is impossible to utilize present equipment, the changes brought about by new war strategies mean increasing conversion of existing units.

"Past experience in plant conversion and machine tool transfers," the report states, "indicates that many plant facili-

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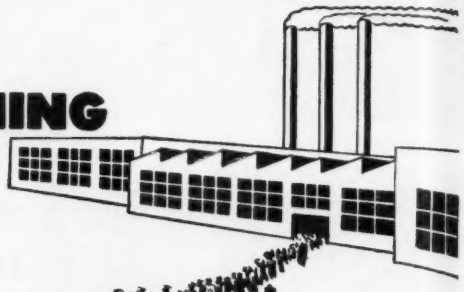
WHEN JOHNNY COMES MARCHING TO WORK



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● Results in war plants throughout America prove that Lyon Production Equipment and Lyon Storage Equipment can contribute a lot in the battle of production.

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ties originally planned for the production of curtailed items can be readily converted to the production of items for which demands are more urgent."

Among recent conversions cited were: Ammunition manufacturers turning to production of aircraft engine parts and instruments; gun shops converting to production of aircraft landing gear; a plant built to make tank armor turning to production of engine cylinders; tank fabricating facilities being used for construction of airframes; and a plant built to make recoil mechanisms changing over to build aircraft landing gear.

Men and Machines Available for War Work

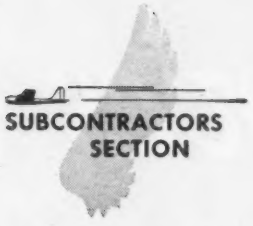
Production facilities—plants, precision tools, and skilled operators—are available to further the war effort. To bring prime and subcontractors together, AVIATION offers this clearing house of information. Address inquiries, with reference to accompanying key number, to AVIATION, 330 W. 42nd St., New York.

Electric Assemblies S-151

West Coast company is expanding facilities to specialize in electrical subassembly work for aircraft and instrument manufacturing. Especially listed is work such as: Assembling and wiring interphone boxes and aircraft panels; assemblies for wiring installations, etc.; assembling radio and other cables, including flex-conduit; assembling and wiring relay and junction boxes; and assembling and wiring various switches. Through a newly developed mock-up process, the lugs in many instances will be applied to the free end at the exact specified length, saving time in installation. The company points out that, at present, it cannot stamp out the machine parts. It will rely on the prime contractor to supply them or have the machine work done by an outside concern.

Precision Metal Parts.....S-152

New York City area machine shop, established 20 yr. and which did automotive parts work prior to war, since then has successfully handled three subcontracts, two on Navy items, one on Army. On latter it was credited for excellence of work. Plant now has open time for work on small precision metal parts, in which it is experienced to tolerances of 0.001. Equipment includes: 18 in. x 10 ft. Bridgeport lathe with compound; two 14 in. x 3½ ft. Reed lathes; two 10 in. x 4 ft. Atlas precision lathes with turret attachments, collets, collet bars, etc.; 16-in. Ohio shaper; #2 Garwin milling machine; Model L, medium Bendix boring mill; 10-ton



hydraulic arbor press; Black & Decker drill press to ½-in. capacity; floor-type Delta precision drill press to ½-in. capacity; 150 amp. Lincoln arc welder; power hack saw; riveting machine; valve refacing machine; gas and electric soldering equipment; paint spraying equipment; bench grinders; center drills, reamers, taps, dies, etc.; lapping plates, surface plates, dial gages, micrometers, etc.

Tool Making Equipment....S-153

Southern California tool company has following equipment available: Two 16 in. x 6 ft. South Bend pedestal-drive precision lathes, complete with taper attachments, chucks, tool holders, and equipment; three lathes, 16 in. x 6 ft., 11 in. x 5½ ft., and 9 in. x 4 ft., respectively, of South Bend motor-driven precision type, complete with equipment; 14 in. x 6 ft. Rockford precision lathe, complete with equipment; 9 in. x 3 ft. South Bend precision bench lathe, max. collet ½ in.; #4 Jones & Lamson universal ram type turret lathe, geared head, complete with bar feed automatic die head master collet, collet pads, tooling, chucks, and regular equipment. Screw machines include: Two Hardinge 2nd operation hand screw machines, push-out type, and four Hardinge 2nd operation, draw-in type. A Nichols hand milling machine with equipment and Bausch & Harris 16-in. shaper are also available. Hammers include 4-in. belt-driven Bradley; #4 Nazel power; and 600# Billings & Spencer drop hammer, complete. Drill presses include: 17-in. Delta floor type; Walker-Turner tapping attachment; Walker-Turner floor type, and 4-spindle Progressive. Total of 15 grinders of various types are also available. Heat treating equipment includes: Three gas forging furnaces; automatic electric liquid furnace, temperature range to 2,400 deg. F.; gas heat treating cyanide pot; bench furnace, and Despatch automatic gas draw pot. Inspection equipment: Model 4-PH Rockwell Hardness tester, complete with standard equipment and diamond point; dial comparator; microscope comparator; and Magnuflux machine with demagnetizer. Miscellaneous units are: Tumbler; Fairbanks Morse counting scale; welding outfit; Delta saw unit with cooling equipment; Walker-Turner band saw; Martin marking machine; and Dumore precision drill and rheostat.

Are you interested in: (1) Reducing time and cost of handling tools and materials; (2) Saving floor space; (3) Increasing protection against fire, sabotage and personal injury hazards?

This comprehensive catalog contains many suggestions for meeting these war-time problems. It illustrates and describes many types and sizes of shop boxes, work benches, portable tool stands and many other items that manufacturers of Airplanes and Airplane Parts are finding most effective in every production operation.

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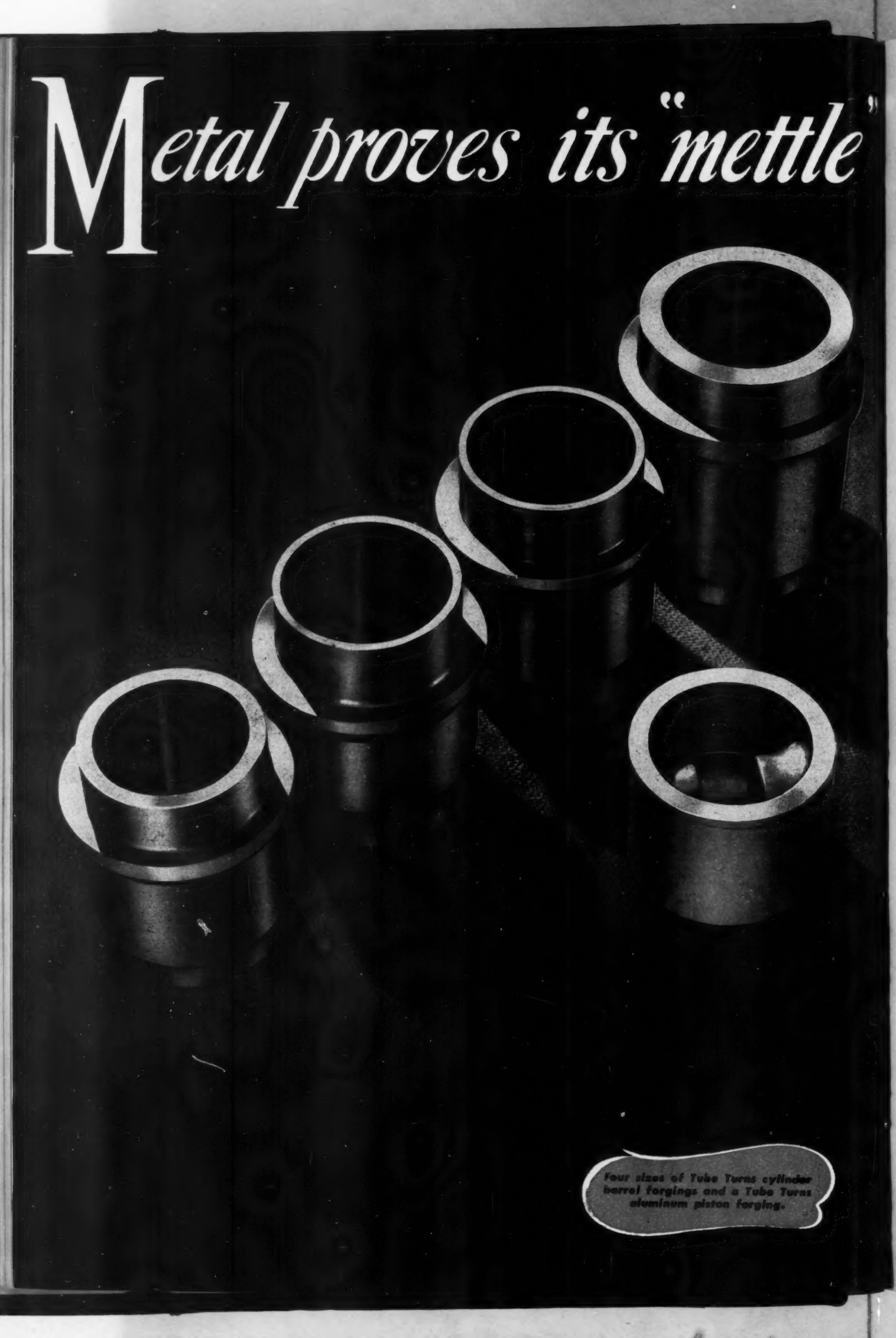


Four sizes of Tube Turns cylinder barrel forgings and a Tube Turns aluminum piston forging.

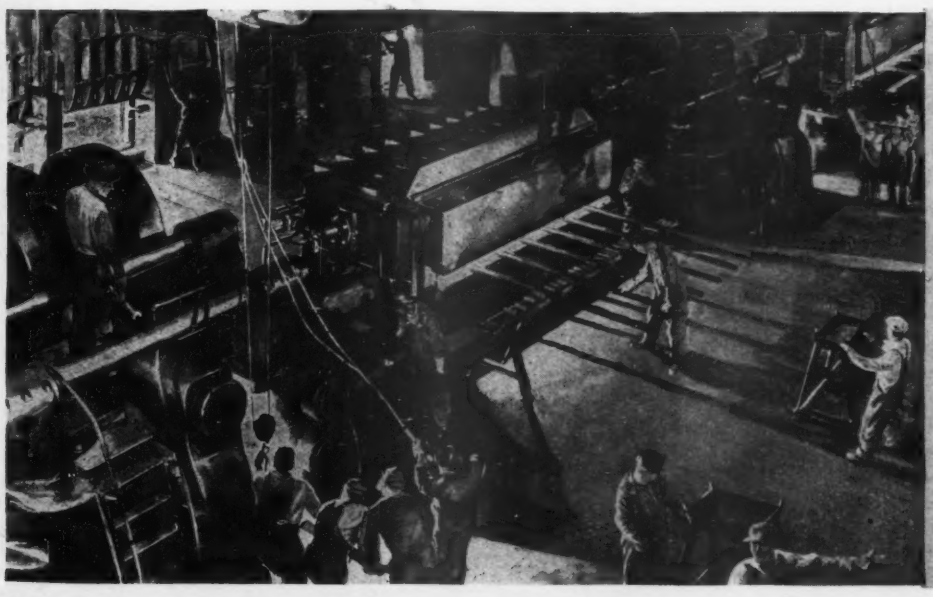
under fire!

AT TUBE TURNS, we do about everything known to modern science to assure unfailing quality in cylinder barrel and aluminum piston *forgings*.

That's why we get a special thrill out of the glowing reports—from every fighting zone—about American airplane engine performance. Facts show that cylinder overhaul or failure is one of the rarest causes of grounding a plane for repairs.

This brilliant record *under fire* makes us realize *all the more* the value of what we are doing and the way we do it: the extreme forging accuracy we demand, the precise heat processing methods we employ, the rigid quality controls we maintain.

The performance of Tube Turns forgings *under fire*—and the *precision-forging* and *careful heat treating* that makes it possible—is earning for us the ever-increasing confidence of engine manufacturers.



GIANT *upsetters*, weighing over half a million pounds and housing huge dies, forge Tube Turns *cylinder barrels* with uncanny speed and precision. Two of these upsetters, with pre-heating furnaces, are shown here.

This forging method, and the important heat treating steps that follow, give cylinders the hardness and metal structure demanded for perfect airplane engine performance.

Tube Turns *aluminum pistons* are forged in ultra-modern, high speed *Maxi-presses*. These huge forging machines permit accurate control of metal flow, for better grain structure and durability in the piston.

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Precision-Forged Cylinder Barrels and Aluminum Pistons

TUBE TURNS (Inc.) . . . . . LOUISVILLE, KENTUCKY

CRUISE CONTROL For Flying Efficiency

Part 1 . . . Power Requirements

By

R. DIXON SPEAS, *Asst. to Vice-Pres. Engineering*
JERE T. FARAH, *Chief Flight Analyst*
SANFORD HINTON, *Flight Analyst*
American Airlines

First of a series, this article considers power demands in airline operation and the means for their efficient control to conserve fuel, achieve specific flight results, pay dividends.

RECENT EXPERIENCE covering, mainly, the past two years in transportation of payloads by planes over long distances has demonstrated the need for a systematic analysis and accurate utilization of the various performance potentialities of each type of airplane operated. That is, it must be known just what power conditions should prevail in cruising flight in order to accomplish desired results from each flight. Control of these power conditions is termed "cruise control" or "power control."

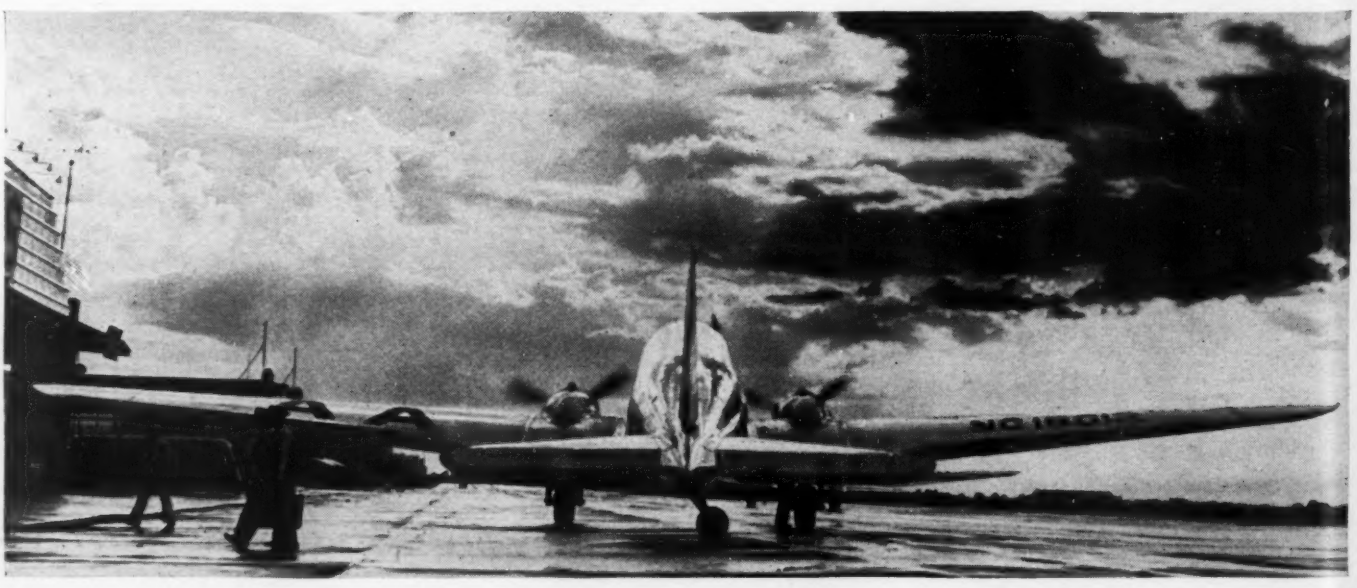
Through use of accurate cruise control, a company may, to the fullest extent, take advantage of the specific qualities of an airplane's performance.

There are several basic types of cruising operation, each designed for fulfillment of some definite purpose to the best of the airplane's ability. These types of operation, and the circumstances dictating the use of each, will be discused in detail later.

Cruise control is a practical necessity in long-range payload-carrying flights from the standpoints of (A) increased safety and (B) increased airplane utility.

It can be readily understood that a preflight analysis of the trip, followed by accurate adherence to the resulting flight plan through cruise control, will result in a conservative, safe operation. This is because of the basic fact that the relation of fuel-remaining to fuel-required is at all times known. This knowledge is as important to the flight as the geographic position of the airplane and should be maintained currently by an accurate power or cruise control.

Another advantage to be gained



For accurate calculation of power requirements, a precise flight plan is necessary. From this it can be decided whether to lay stress on economy of time or of fuel.

through the use of intelligent control of the cruise is that of carrying the maximum possible payload on a given flight. If a system of cruise control is known to be dependable, a pre-flight analysis of the trip will produce an accurate prediction of fuel required, with the result that the flight carries only the necessary fuel, instead of an oversupply, which weight may as well be valuable payload.

The value of cruise control increases proportionately with flight length; percentage errors become considerable in operation over long ranges. For this reason, in view of ever-expanding air transport routes and services, this discussion is believed to be especially timely.

During any flight, no matter how short or how long, power output of the engines must be controlled. Power may be controlled in a very haphazard manner, or the use of power may be a very carefully planned part of aircraft operation. Power cannot be too carefully controlled.

There are various types of cruising which may be accomplished by power control. The main types are as follows:

1. Maximum endurance
2. Maximum range
3. Constant instrument air speed
4. Constant power
5. Maximum speed
6. Rapid fuel consumption
7. Maximum payload miles per hour
8. Maximum payload miles per dollar of operating costs.

Each of the various types of cruising listed above fulfills a definite purpose, although some may overlap others in their uses. The reasons for, and the means of, accomplishing each type are discussed in detail as follows:

1. Maximum Endurance

Maximum endurance means staying in the air for the longest period of time using a minimum amount of gasoline. A common example of maximum endurance occurs when an aircraft is approaching an airport at which instrument approaches are being made because of low ceiling and visibility. As so often happens, several aircraft approach the vicinity in which the airport lies. Only one aircraft at a time is allowed to make the final instrument approach, so the others must wait, and each is usually assigned a definite altitude to hold, there being at least 1,000 ft. difference in altitude between planes. At such a time, if there is any reason to conserve gasoline, the pilot flies "maximum endurance."

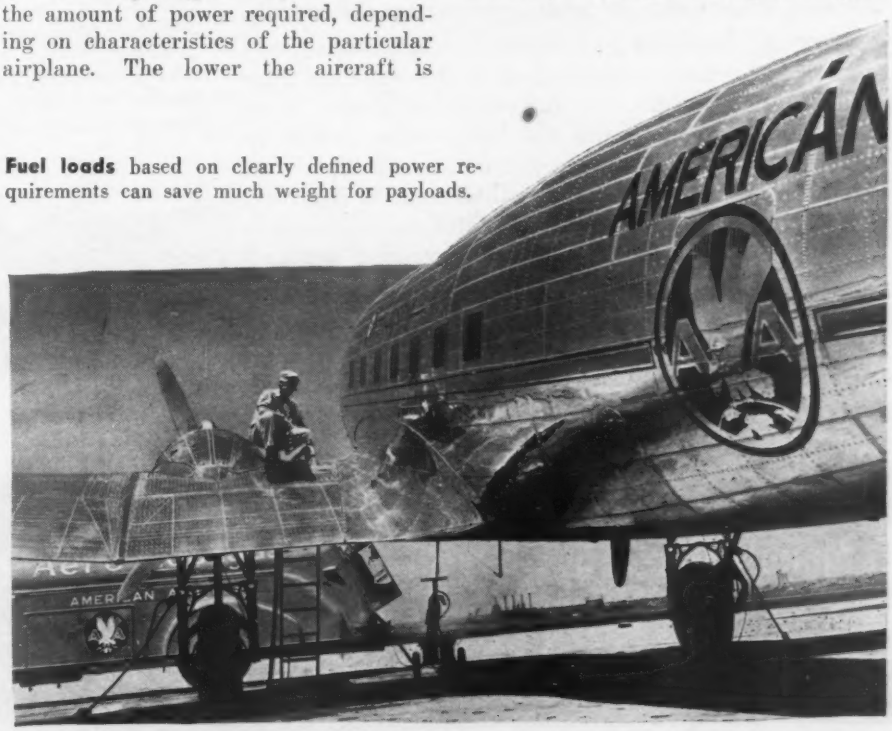
Other examples of maximum endurance occur when a pilot is awaiting clearing of combat activity, waiting for weather to clear, or for dispatch clearance. In summation, maximum endurance would be flown at any time a pilot wishes to remain in the air for a maximum length of time using a minimum of gasoline.

The power for maximum endurance is the minimum power required to maintain controllable level flight. Such power is usually specified by reference to corresponding instrument airspeeds. These airspeeds are usually approximately 1.3 times the stalling speed.

Use of flaps may or may not decrease the amount of power required, depending on characteristics of the particular airplane. The lower the aircraft is flown, the lower is the amount of power required for maximum endurance, since higher altitudes require higher true airspeeds to keep from stalling, although instrument airspeed at stall is the same at all altitudes. Higher speeds require more power. Therefore minimum power and minimum fuel consumption is attained at a minimum altitude.

The instrument airspeeds at which maximum endurance is attained will, of course, vary with weight, just as stalling speed varies with weight. For small airplanes the range of weights is not sufficient to cause an appreciable range of airspeeds. For the modern transport, however, the range of weights as gaso-

Fuel loads based on clearly defined power requirements can save much weight for payloads.



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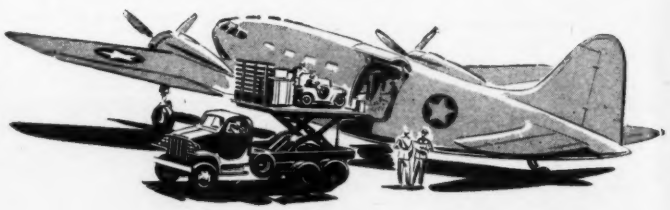
If you are looking for ways to cut loading time — to maintain a reputation for on-schedule operation — Heil engineers are ready to collaborate in developing custom-designed Heil Air Freight Loading Units to meet your specific requirements. Write, phone, or wire.

BH-72

The Heil Co. since 1901 has been engaged in developing and manufacturing specialized types of transportation equipment for the petroleum, mining, and construction industries — for municipal and other government services — for distribution of bulk and package goods. The basic principle of the Heil Air Freight Loading Unit has been proved by years of experience.



Utility models for military use. Streamlined models for the airlines.

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Contractors to the U. S. Army, Navy, and United Nations Air Services

TABLE I—SPEEDS FOR MAXIMUM ENDURANCE WITH DC-3

Weight Range, Lb.	Instrument Air Speed, Mph.
29,000–27,000	115
27,000–25,000	112
25,000–23,000	108
23,000–21,000	105

TABLE II—SPEEDS FOR MAXIMUM RANGE WITH DC-3

Weight Range, Lb.	Effective Headwind, Mph.				Effective Tailwind, Mph.		
	−60	−40	−20	0	+20	+40	+60
29,000–27,000	147	142	137	133	128	124	119
27,000–25,000	141	137	132	128	123	118	114
25,000–23,000	135	131	126	122	118	113	108
23,000–21,000	129	125	121	116	112	107	103

line is consumed causes an appreciable range of airspeeds for maximum endurance. Typical instrument airspeeds for a Douglas DC-3's maximum endurance are given in Table I.

2. Maximum Range

Maximum range means flying so as to attain maximum miles per gallon. This type of operation would be used on very long range flights where every gallon of gasoline must be used to get to the destination safely, or when it is desired to carry the maximum amount of payload on any one airplane trip. The greatest weight of payload on any trip is possible when the minimum weight of gasoline is used to reach the destination. Use of minimum fuel to reach the destination is achieved by flying maximum range.

The two main factors which affect the instrument airspeeds at which maximum range is attained are effective wind and gross weight at which the aircraft is flown.

Table II shows typical instrument airspeeds for maximum range for a Douglas DC-3.

It is to be noted that "instrument airspeeds" are shown. This type of table is the most basic and simple one for guidance in maximum range operations. At any one instrument airspeed, and wind and weight condition, the same number of miles per gallon are realized at any altitude at which the required instrument airspeed can be reached in the cruising power range of the engines, provided propeller efficiency and specific fuel consumption of the engine are constant. For all practical purposes this is true for engines with mixture control for carburetors and with constant speed propellers. For aircraft not having these advantages, maximum range is attained at the altitude at which the ratio of propulsive efficiency divided by specific fuel consumption is a maximum.

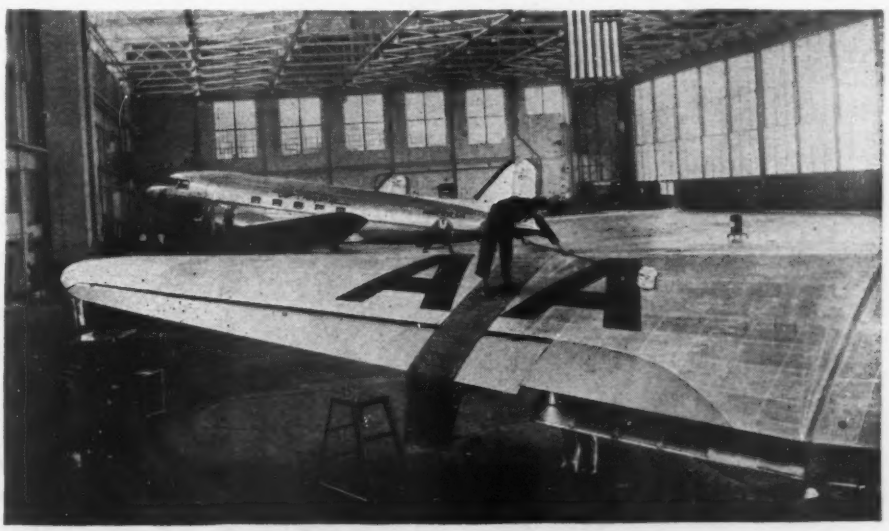
Assuming the ratio of propulsive efficiency divided by specific fuel consumption is a constant, the reason that the same number of miles per gallon can be attained at any altitude is as follows: For any given instrument airspeed the power required is greater at higher altitudes, varying as the square root of the ratio of air density at the two altitudes. At the same time, however, true airspeed for a given instrument airspeed varies in the same proportion, namely as the square root of the ratio of air density at the two altitudes.

Thus a higher altitude requires a greater power for any given instrument airspeed, but the true airspeed also is greater in the same proportion, so miles per gallon are the same. The altitude is then limited to that at which the power required is maximum cruising power for the engines. It must be remembered that more fuel is required to climb to a higher altitude than to a lower one.

Of more importance in selection of altitude for maximum range is the effect of wind. Altitude should be selected at

(*Turn to page* 333)

Maximum payload is the prime objective, especially when it comes to freight. This must often be balanced against considerations of speed of delivery, which means more fuel or less cargo.



A clean airplane is more efficient. Smooth waxed finish and a pre-flight inspection insure maximum results from power expended.

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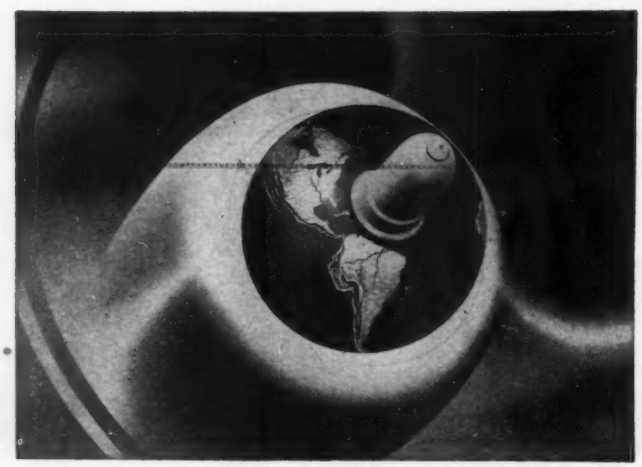

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OBJECTIVE — To bring interpretive journalism to aeronautical news presentation—at top speed—to the top men.

EDITED BY — Robert H. Wood, well-known aviation news analyst, will direct a seasoned editorial staff in Washington, D. C. Other editors and correspondents in key cities here and abroad.

CIRCULATION — 10,000, by subscription only.

SUBSCRIPTION—Charter rate, one year, $5; three years, $15.

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FIRST ISSUE — August 2, 1943.

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EDITED BY— Fowler W. Barker, longtime secretary of the Air Transport Association, will direct editorial staff headquarters at New York, assisted by editors and correspondents at key points.

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FIRST ISSUE—September, 1943.

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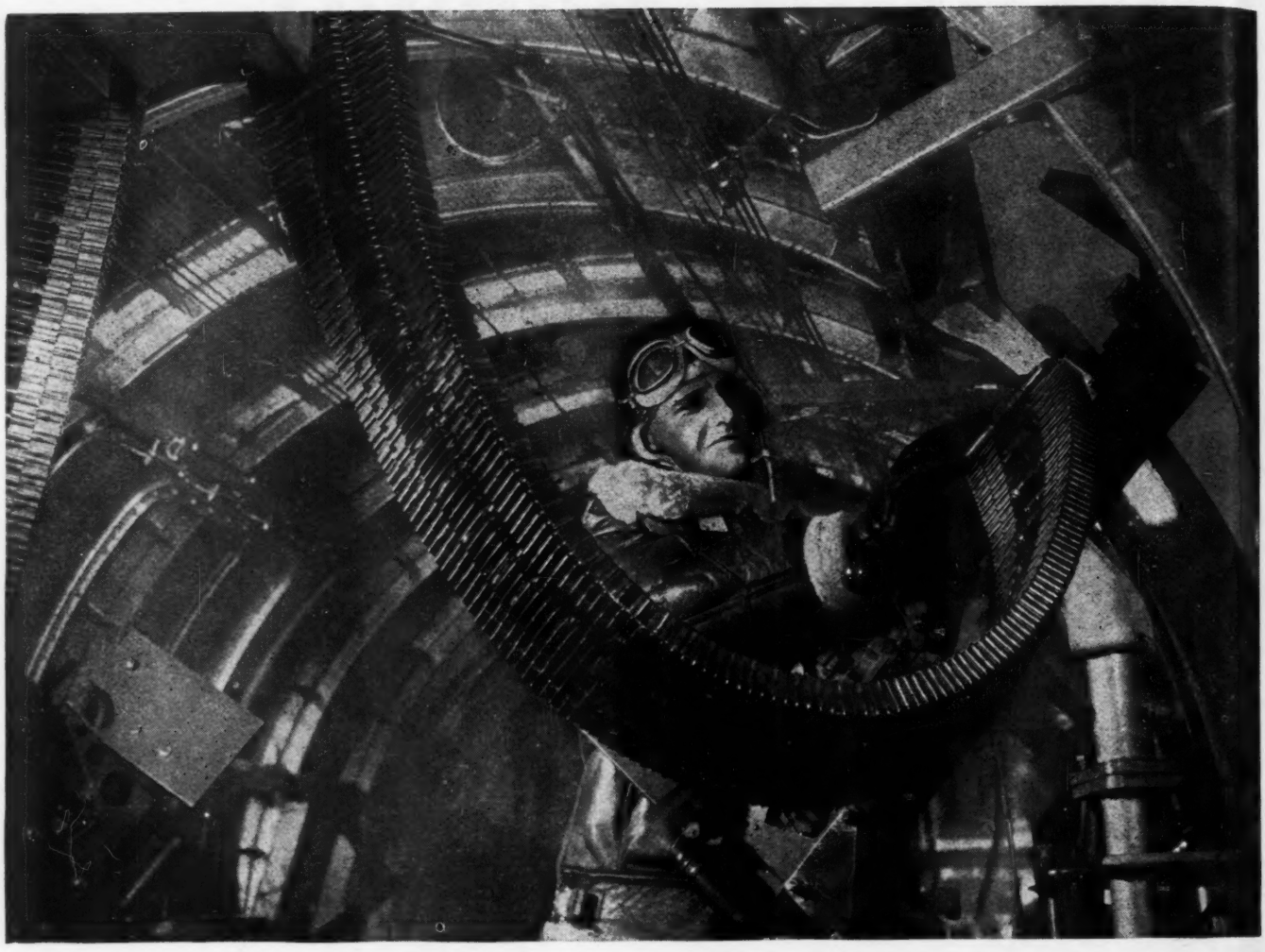

600 ROUNDS-A-MINUTE...*per Gun!*

INSIDE this Flying Fortress, the side gunner inspects belts which feed up to 600 bullets a minute as the big ship gets set for a trip over enemy targets. For guns like these, the need is absolutely vital for unlimited amounts of ammunition.

In producing not only the ammunition, but guns, planes, ships, tanks, and other weapons, war plants everywhere are increasing output and lengthening cutting-tool life, by using *Texaco Cutting Oils.*

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TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT – CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

MAINTENANCE

International Overhaul

Engine change and major check on a Douglas C-54. On large ships this job must be done wherever there is space, and in the biting cold of a Canadian winter it takes the know-how of experience, which has been given freely by Canadian flying veterans.

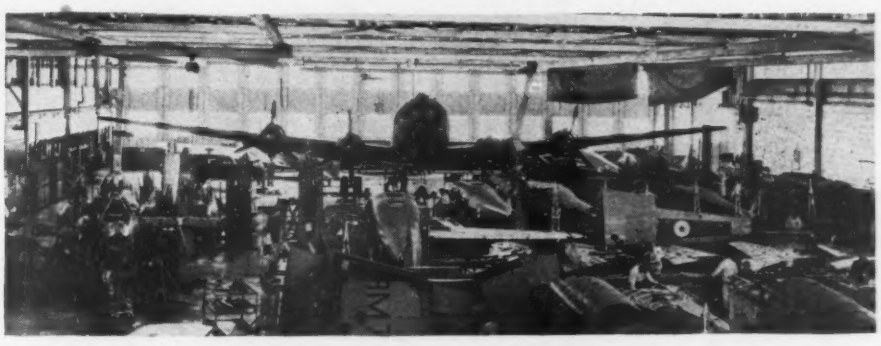
An inside view into one of Canada's most completely equipped repair shops which, situated on the main route to Alaska, works for three countries.

MANY an American airplane which has met with bad luck while operating through northwest Canada has soon gone on its way again none the worse for wear—thanks to a repair base in Edmonton that has rendered indispensable service to the United States as well as to Canada.

Aircraft Repair, Ltd., handles everything from service checks to major crack-ups on 25 or 30 different types of planes and performs routine major overhaul on both airframes and engines. This includes advanced trainers from Air Training Program schools in all of Alberta and half of Saskatchewan, as well as operational models, also engines crated in for overhaul. The engine shop can handle, if necessary, up to ten or twelve engines a day, although the average is four to six. Seven or more different types are included.

Like most aviation concerns in Canada, this company and the men in it have their roots far back in the commercial operations which have paved the way for most of the present airlines.

President of Aircraft Repair, W. L. Brintnell, learned to fly in 1917 with

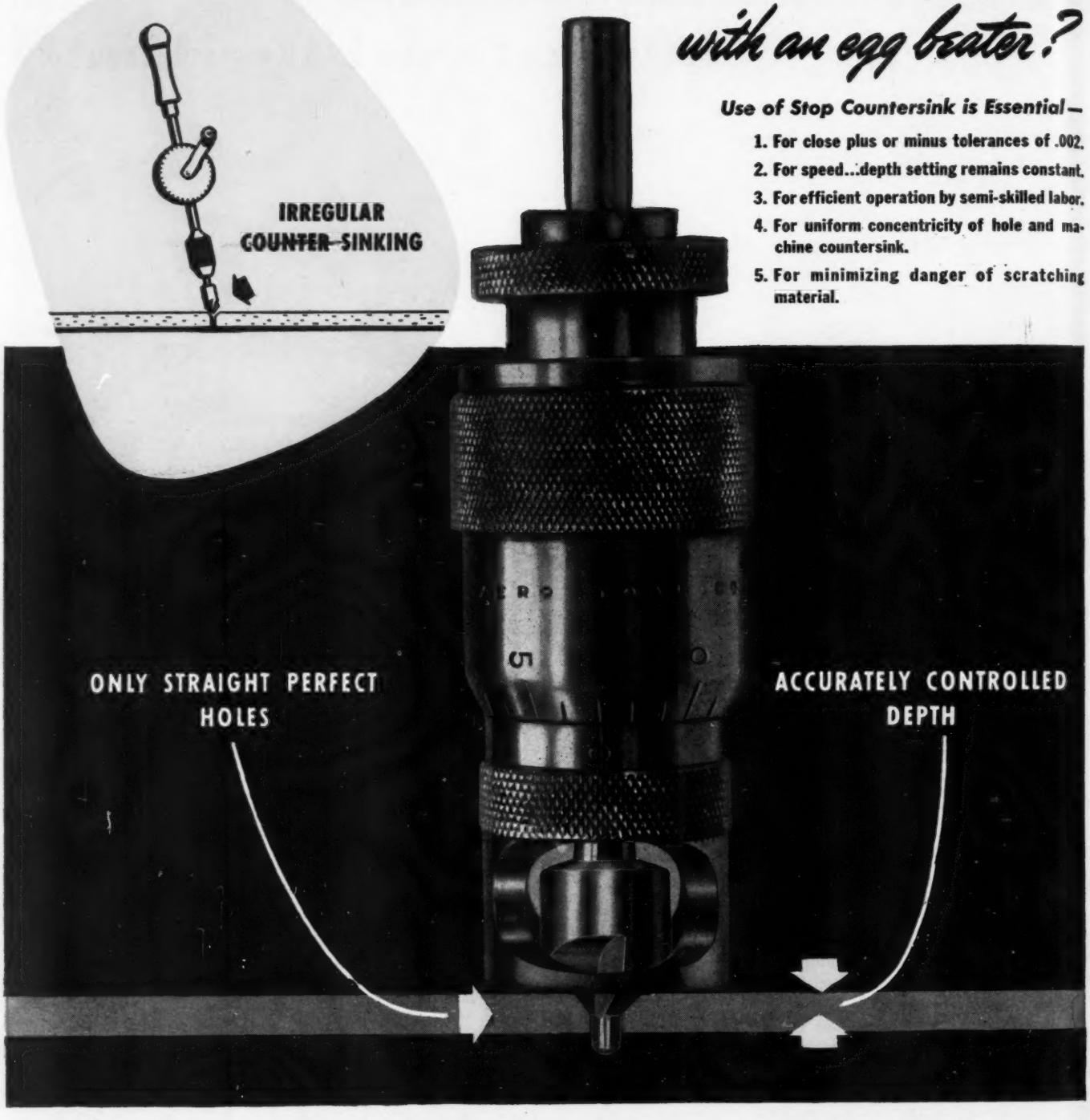


View of tear-down and repair hangar, where planes of all types are overhauled. Gas and arc welding facilities, propellor, instrument, and accessories shops with test equipment make this plant the most complete in western Canada.

Assembly hangar where repaired units are brought together. Factory subassembly methods are followed throughout.

CHOPPING OUT SQUARE CIRCLES

with an egg beater?



Use of Stop Countersink is Essential—

1. **For close plus or minus tolerances of .002.**
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Aero Tool Stop Countersinks alone offer all these features: Increments of .001 with broached adjustment . . . positive locking, spring loaded, easily operated. ● Absolute concentricity of spindle, cutter and pilot assured by cutter inserts and seats on No. 00 stub taper. ● Concentricity within .001 of total indicator reading maintained by ground external spindle diameters and No. 00 internal taper. ● Longer life . . . no frictional heat . . . through use of ball radial and oilite bronze thrust bearing. ● Split keeper gives positive set to retainer collar on bearings . . . a proven principle used in engine valve spring design ● Cutters are cam ground . . . a special grinding process perfected for aluminum alloy materials.

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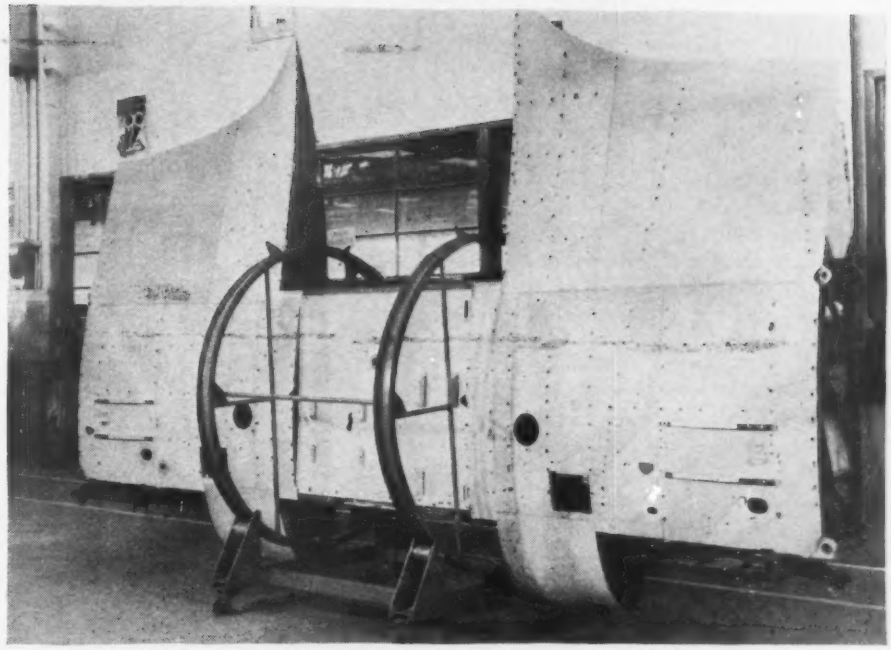
Rotating repair dolly for Airspeed *Oxford* center wing sections, devised and built in the shop. Circular frames, split to admit wing section, turn to any position and lock in place at bottom.



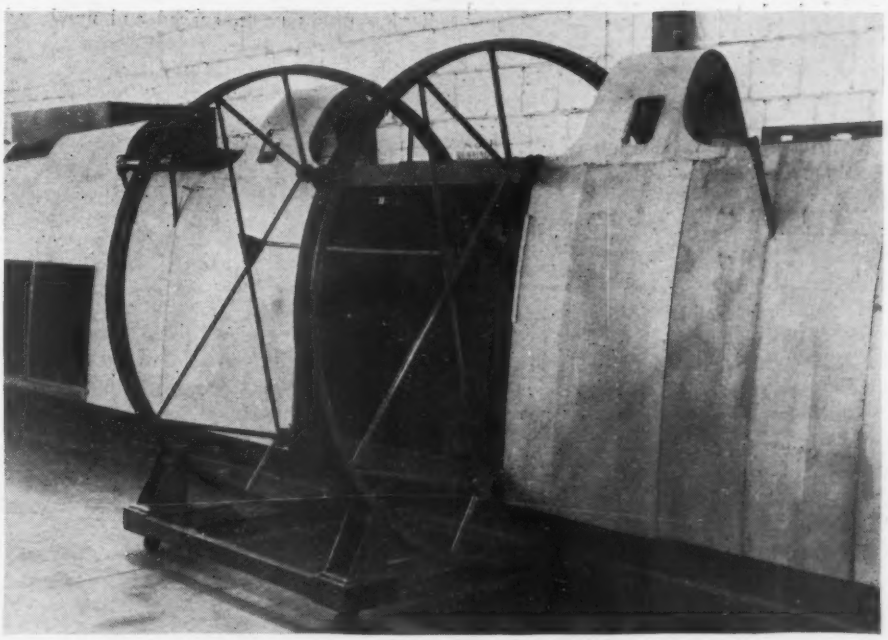
the RAF, joined the staff of Western Canada Airways in 1927, and became assistant general manager of the enlarged Canadian Airways in 1931. He flew the first prospectors in to Great Bear Lake—a region now famous for oil and radio-active ores. In 1932 he left Canadian Airways to organize his own airline, the Mackenzie Air Service, beginning operations with the first of 1933. The present general manager of Aircraft Repair, Mr. Hayter, also flew with him at this time.

The base at Edmonton provided maintenance for the line and by 1938 began taking overhaul work for United Air Transport, which later became Yukon Southern. From the first few months, the Mackenzie Air Service prospered, and it had grown to 14 airplanes by 1941, many of which were twin-engine all-metal craft.

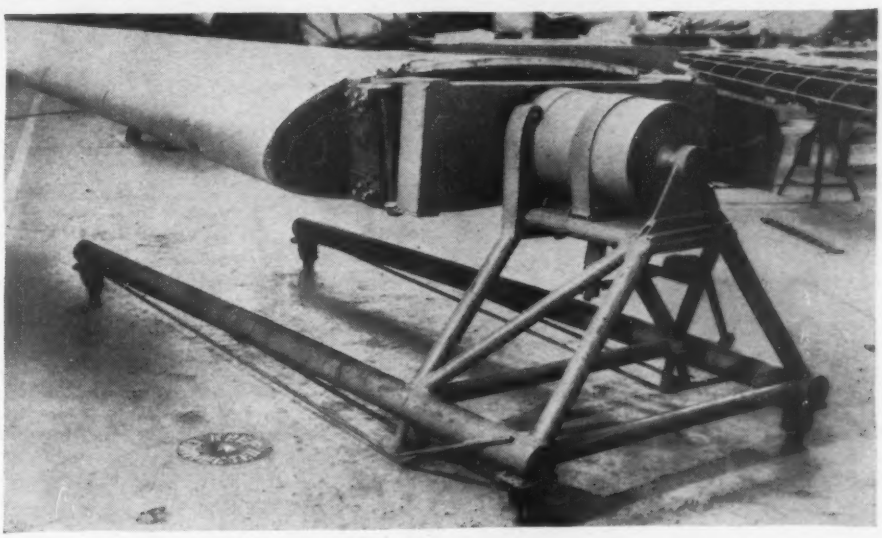
At this time Canadian Pacific bought controlling interest in the line, and Mr. Brintnell concentrated on forming a repair and overhaul company in Edmonton. Having flown all over the Northwest and down the valley of the Mackenzie, which ranks with the Mississippi as one of the large rivers of the world, he became convinced that Edmonton would become a center of activity for this region. From the airline staff capable men were chosen and sent to factories in the U.S. to study the most advanced methods of metal working and repair.

The coming of the war found here a small but capable shop ably staffed by seasoned men who had gained their experience with the Mackenzie airline. The Alaska Highway was begun. The U. S. Army moved through with more and more craft. With the British Air Training Program already under way, the Dept. of Munitions and Supply gave out a contract for expansion of equipment and staff, and advanced trainers began to pour in from flight schools in two provinces.

The U. S. Army had obtained use of one hangar owned by Canadian Pacific, but facilities for anything beyond routine servicing were not ready, hence the equipment at Aircraft Repair was offered to help out. Later on two U. S. Army hangars were erected, but the immediate result was that all major



Avro "Anson" wing dolly. The entire wing is a single section, and the problem of maintaining it in any desired position is greatly simplified by this fixture.



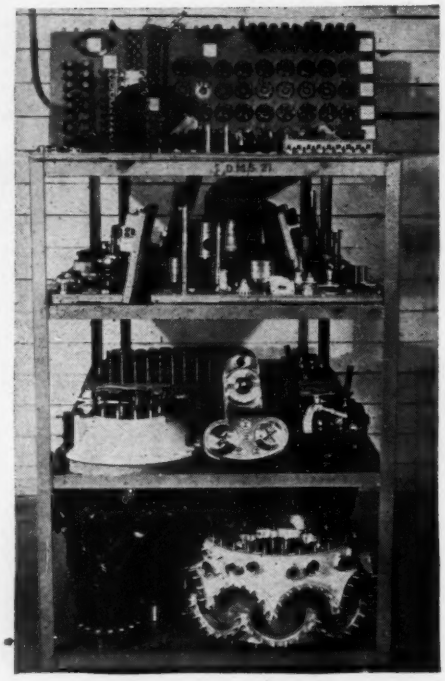
North American "Harvard" outer wing panel holding jig. Rolling fixture is supported on old engine bearings, and the device is full-cantilever for easy access and change of position.

overhaul and repair was given over to the Canadian shop. Since the Army was for the most part merely passing through and most planes were new deliveries requiring only service, they were glad to turn over damaged craft and overhaul operations on the hard working transports to already equipped shops.

Cooperation in a common cause between Canadians and Americans has been splendid. The Army supplies parts, the repair company rebuilds, overhauls, and winterizes. It was only to be expected, in this wartime rush to the north into extreme low temperature operations, that there would be numerous things which could be learned only by experience. Many of the modifications worked out below the border had to be revised with the knowledge of actual operation. Temperatures down to about 30 deg. below zero had been fairly well anticipated, but beyond this, to extremes of 60 below, reactions were sudden and severe. Here, the knowledge gained by Canadian flyers and mechanics in years of rigorous winter flying has been freely given and gratefully accepted.

The fact that all-metal airplanes had been used on the Mackenzie run had provided a rather complete sheet metal shop. Subsequent expansion has made this department equal to any job, and metal surfaces for every need have been manufactured within the plant.

Cowlings have been revised, changing airflow to meet low temperature requirements as indicated by thermocouples placed around the engine. The propeller blast at 40 deg. below zero congealed oil in reduction gears and caused trouble. To overcome this, "dishpan" covers were fitted in two pieces around the propeller hub over the gear housing to shield it from excessive cooling—a device commonly seen on aircraft in this region.



Engine parts rack, spaced and numbered for every item, with arrangement in related groups, allows instant check of completeness. Replacement of parts by number from stores requires less knowledge of engine components.

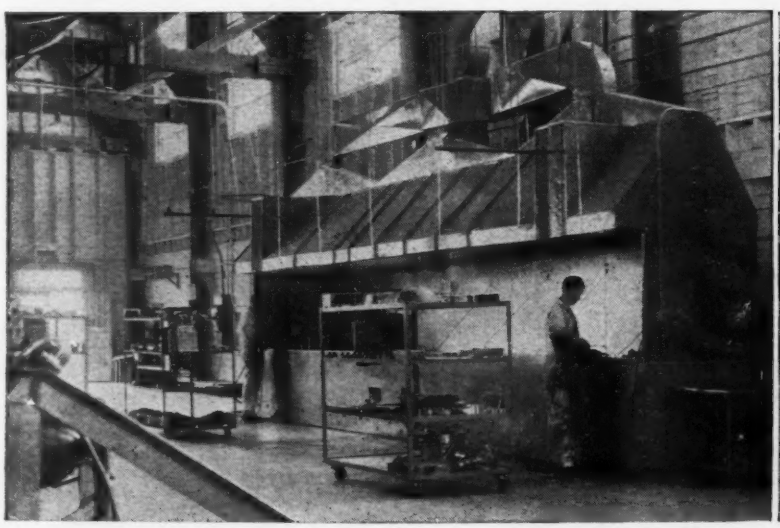
Use of oil dilution systems required some coaching. Occasionally a dilution valve will stick, causing the oil to be washed out by gas and frothed out at the breather, bringing both fire hazard and danger of seizing in the engine. Proper emphasis on very careful oil pressure check at this point cautioned pilots to give themselves time to act—either to pump the dilution control to clear the valve or to shut the engine off before damage resulted.

The variety of planes and jobs which has been dealt with is impressive. There was a P-39 which had made a hard landing in snow, tripped on a snow drift, and nosed over, bending the nose section and shaft. To align this part of the plane properly was an operation never before tried away from the factory. The engineering department went to work and built a nose section jig, removed the buckled inner plates behind the gear box, put in stiffeners at this point, and straightened out the forward frame. Plumb bobs were hung from the rudder, center of fuselage midway, center of reduction gear housing, and center of propeller hub. A tightly stretched piano wire lined up underneath furnished an index line to check alignment throughout the whole length. When finished, the forward reference points were absolutely true, and with a new shaft installed the plane flew as smoothly as as when it left the factory.

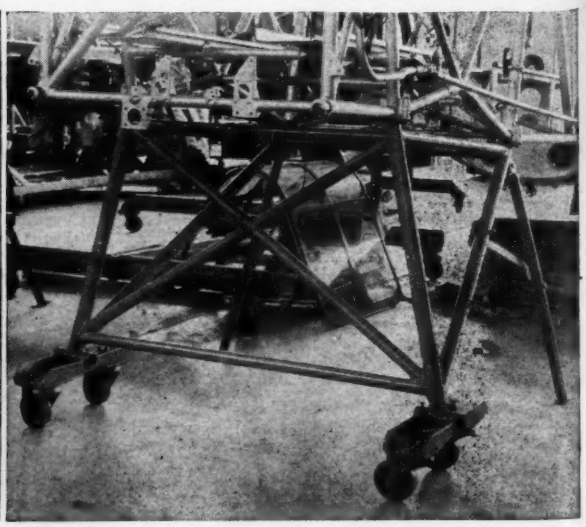
Several cracked-up P-40's have been

(*Turn to page* 343)

Jig which was made up to align the reduction gear box and shaft on a Bell P-39.



Cleaning tanks feature unusually good ventilation, with blowers which can deliver cool air in summer or warm air (with heaters attached) in winter. Fumes are carried off by ducts, fitted inside section seen directly in front of men, creating draft toward back and upward.



"Harvard" fore fuselage section assembly support, designed to be easily moved about on double casters, can be lifted over wires or hoses without raising whole weight at once.

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THE P51-MUSTANG by North American, equipped with Taylor Tabs

. . . and Taylor Took It From There

In the Mustang fighter, one of America's great fighter-bomber airplanes, North American Aviation, Inc., had a trim-tab problem that was right down Taylor Fibre's street. Between us, we developed a phenol fibre tab of simplified construction that:

1. Would meet strength-weight requirements.
2. Would not ripple under stress.
3. Would take no permanent set under load.

Just another example of teamwork between the engineers of your industry and ours . . . a pooling of experience, *plus* our *Verifibre* Process, which checks and verifies materials and methods every step of the way in just about the finest plant ever to raise its broad shoulders above ground.

We cannot promise miracles in this era of manpower and other shortages. We are not magicians. But we invite you to "Take it to Taylor" for discussion, with blueprints spread on the table. Maybe we can help. We'll be the first to say so if we can't.

Other outstanding ships on which Taylor Tabs are used include the Bell P-39 Airacobra and the Martin B-26 Bomber.

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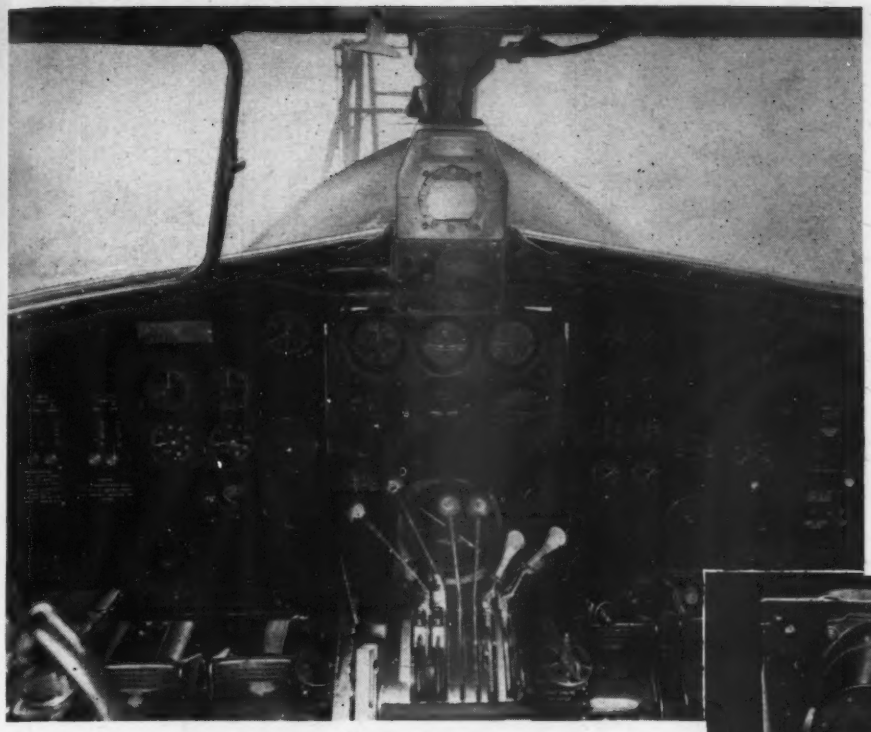
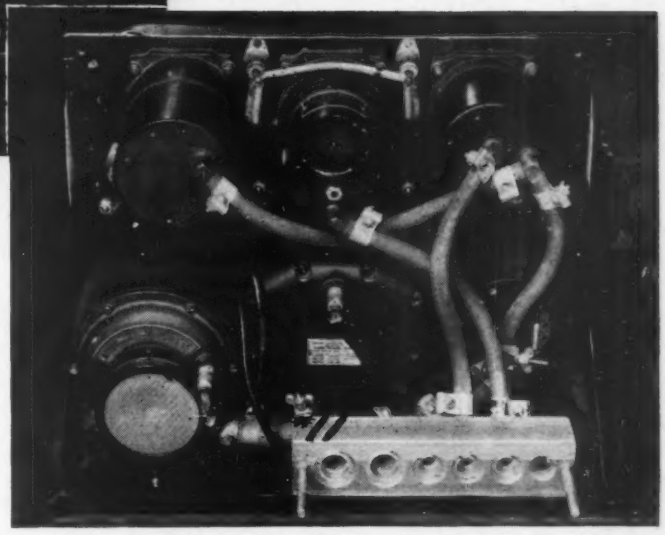
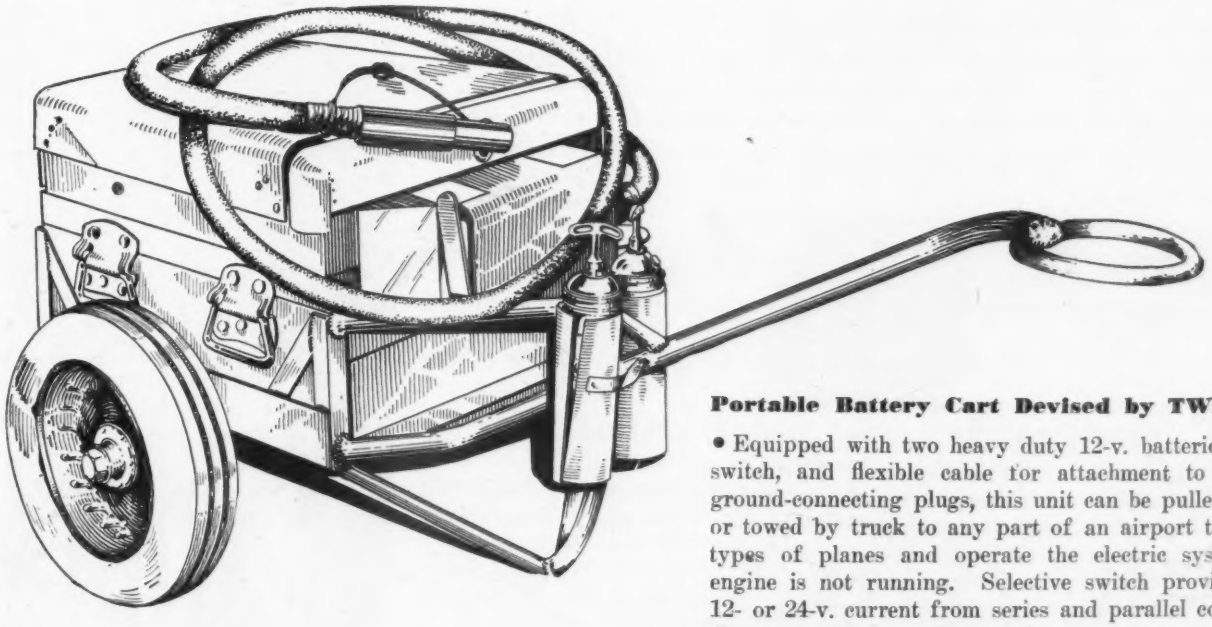




AVIATION'S MAINTENANCE NOTEBOOK

Instrument Panel on Chicago & Southern "Dixieliner"

• For speed and accessibility in overhaul and service of the flight group, Chicago & Southern has set up this separate instrument unit which can easily be disconnected and removed independently of the others. In case of failure of any instrument in group, set can be removed and replaced by a spare in no more than ten minutes. Rear view (right) illustrates compact plumbing connections to manifold for suction on bank-and-turn, gyro horizon, directional gyro, pitot static, and electrical connection for lighting.



Portable Battery Cart Devised by TWA

• Equipped with two heavy duty 12-v. batteries, selector switch, and flexible cable for attachment to airplane's ground-connecting plugs, this unit can be pulled by hand or towed by truck to any part of an airport to start all types of planes and operate the electric system while engine is not running. Selective switch provides either 12- or 24-v. current from series and parallel connections, thus ground crew may service many types of planes from one cart. On 12-v. output with parallel connection, the charge lasts much longer than from a single battery. Cable is carried inside cover when not in use.

Living a Long Life

The characteristic you demand in a capacitor is long life. And in this all-important matter the record of Tobe Capacitors is an enviable one, with almost complete absence of "returns."

Lasting stamina is built into Tobe Capacitors through every step in their manufacture and is cross-checked by frequent, rigid inspections. Electrical ratings are always on the conservative side. Research is continuous in the search for an even better way, an even higher standard.

Type DP Molded Paper Capacitor shown below is the first oil-impregnated condenser to be found physically and electrically interchangeable with the majority of mica capacitors used in the by-pass and coupling circuits of radio and radar equipment. For the first time since its introduction we are now in position to accept immediate orders with *prompt delivery assured.*

LONG LIFE **ASSURED**

SPECIFICATIONS—TYPE DP CAPACITOR

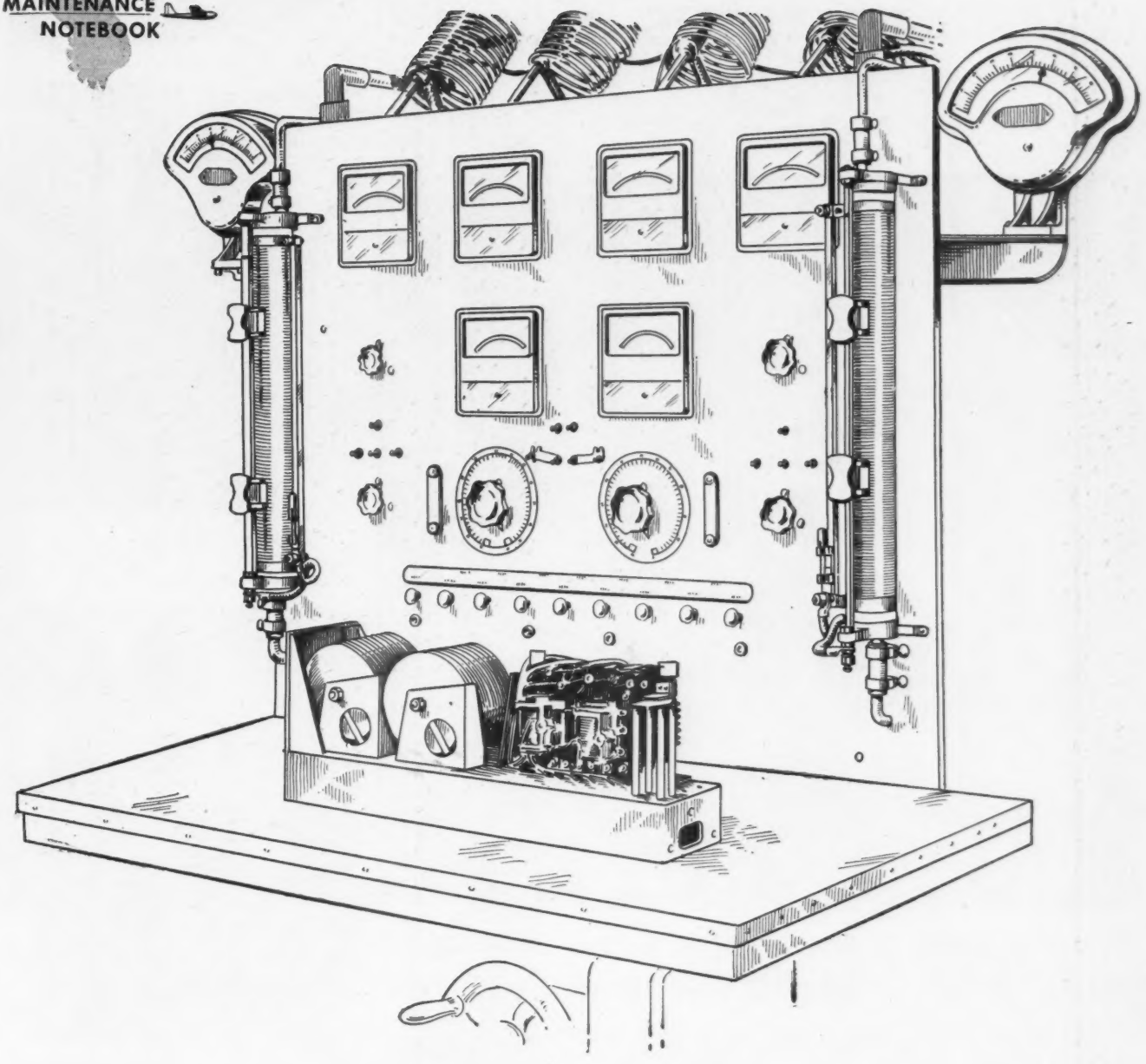
CAPACITANCE	.001 to .01 mfd.
WORKING VOLTAGE	600 volts DC—flash test 1800 volts DC
SHUNT RESISTANCE	At 185° F.— 1000 megohms or greater At 72° F.—50000 megohms or greater
WORKING TEMPERATURE RANGE	Minus 50° F. to plus 185° F.
OPERATING FREQUENCY RANGE	Upper limit 40 megacycles Q at one megacycle—25 or better
POWER FACTOR	At 1000 cycles—.005 to .006

These capacitors meet Army and Navy requirements for immersion seal.

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

A SMALL PART IN VICTORY TODAY—A BIG PART IN INDUSTRY TOMORROW

AVIATION'S MAINTENANCE NOTEBOOK



UAL Generator Test Panel

• For testing dual generators with their control unit, this stand is run by two variable-speed control motors for operating generators from 0 to 5,000 r.p.m. Tachometers are at upper corners of panel. Two water-cooled 4,000 w rheostats, for various loads and for adjusting reverse current relays and current limitator settings, are mounted vertically at left and right. Four Nichrome coils are at top back of panel, used for a constant load of 80 amp. First meter at upper left is field current meter for left generator, indicating amount of current passing through voltage regulator and current limitator contacts in control unit which is on bench. Next is the output meter for left generator, indicating load being carried.

Two right hand meters function correspondingly for right generator. Directly below are two voltage check meters for the generators. Two rheostat dials below are in series with the field currents and will raise and lower voltage without changing generator r.p.m. To right and left of voltmeters are two knobs for changing scales on the field current meters —0 to 5 amp., 0 to 150 amp. Two more knobs, directly below, select one of three scales for the voltmeters—0 to 25 by fives, 0 to 5 by ones, 0 to 50 by tens—purpose being to accommodate various types of equipment.

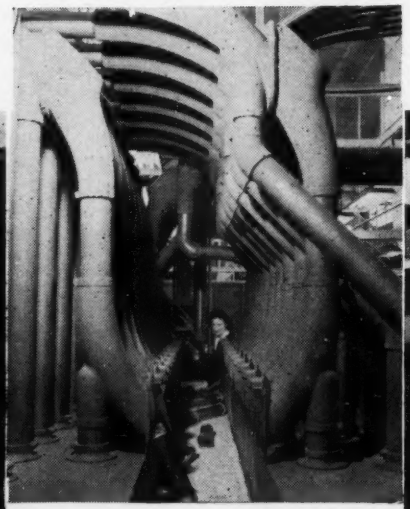
Nine switch buttons across bottom operate (reading from left to right) as follows:

(1) Connects left generator circuit to test panel; (2) constant load switch connects to load coils at top rear; (3) connects water-cooled rheostats to circuit for various loads desired on left generator; (4) connects a 12-v. battery to circuit for checking changing rates, reverse current relays, etc.; (5) center switch connects generators to other batteries, throughout the shop, which are kept charged by using generator output during tests and run-ins; (6, 7, 8, and 9) duplicates for right generator of left hand set of four.

When all buttons are "in" (except extreme left) this generator is operating as a single unit. With extreme right button also "out", right generator is brought "in" and the two are in parallel. Load applied by different switches will balance automatically to give each generator equal load distribution. Unit was designed and built at UAL base.

SWIFT . . . SURE . . . SILENT COMMUNICATIONS BY AIR

AT BELL *Aircraft*



Central Pneumatic Tube Desk in Production Control Office. Incoming carriers are discharged on belt conveyor to Despatcher for examination and re-despatch.

Inter-linking and sub-station for receiving and despatching carriers in the plant.

27 DEPARTMENTS ARE WITHIN A FEW SECONDS' REACH WITH STANDARD PNEUMATIC SYSTEM

With Airacobra-like speed — the transparent type document carriers are transmitted through miles of the Standard Pneumatic Tube System, stretching in all directions in the mammoth assembly plant of the Bell Aircraft Corporation, located at Niagara Falls, N. Y. The twin line system connects the Main Intra-Plant Traffic Control office within a few seconds' reach of 27 important divisional departments located in the sub-assembly and main assembly sections in the plant, and the distant Production Hanger located on the site.

Direct inter-communicating service is provided to the 22 sub-stations through the Main Central Desk. Five relay stations are served by inter-relay despatch service from the respective inter-linking sub-stations. The carriers travel in silence at a speed of approximately 30 feet per second, and are received in a compartment of a specially designed metal cabinet. Each cabinet is fitted with electrical contacts and a red bull's-eye light to announce the carrier arrival.

The system serves the Electrical Division, Final Assembly Line, Rework and Development Department, Salvage Inspection, Raw and Master Stock Rooms, Flexiglass and Cable Department, and the Government Equipment assembly division. Service is also extended to the Final Inspection, Receiving, Shipping, Crating, Engineering and Blueprint Room. A sub-station serves the Plant Managers Office, Engineering Division, Labor Statistics and Accounting departments.

Cabin Assembly, Tail and Front Fuselage Assembly, Tool Inspection and Maintenance Departments are served via the inter-relay connections. Lines spanning a distance of 2000 feet connect the New Production Hanger with the Central Operating Station.

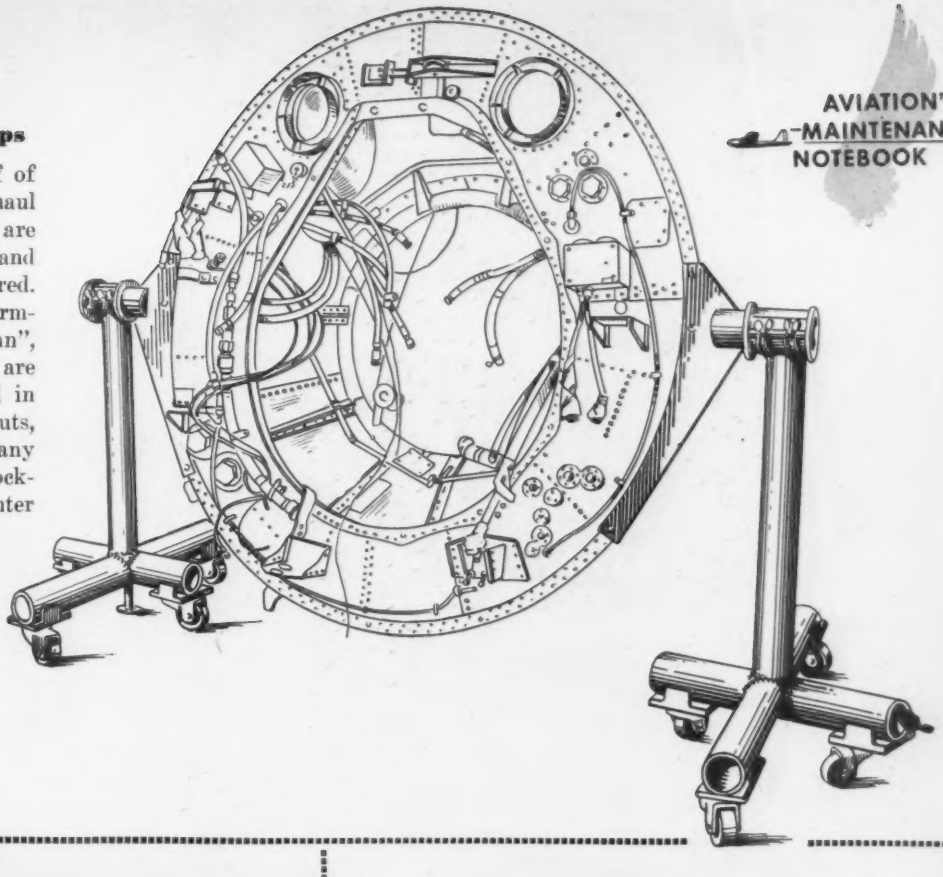
This pneumatic tube system is one of the largest and most notable built and installed by the Standard Conveyor Company. Write for information concerning the advantages of a similar installation for your plant.

STANDARD CONVEYOR COMPANY
General Offices: NORTH ST. PAUL, MINN.
Sales and Service In All Principal Cities

ENGINEERED FOR FASTER PRODUCTION

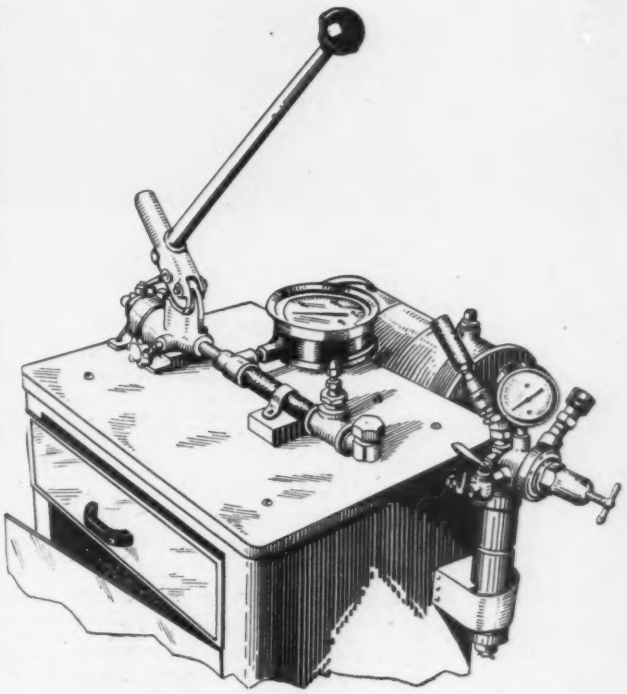
"Dishpan" Dolly in PAA Shops

• Designed by A. P. Peria, chief of Pan American's engine overhaul shops in New York, these dollies are welded of spare pipe, are stable, and can be moved anywhere desired. Metal fins with bolt holes, conforming to shape of engine "dishpan", support the assembly. They are mounted on short shafts carried in split bearings clamped by wing nuts, thus assembly can be fixed in any position for ease in working. Locking device is provided under center of stand.



UAL Piston Ring Lapping Fixture

• With aid of a flat-strip ring clamp to compress rings, cylinder is eased down over dummy head of this machine and bolted in place for operation. Power is furnished by compressed air at 110 psi. with a two-way valve for reversing the stroke. Spiral slot gives 40-deg. rotation of dummy piston at each stroke. Used for final ring finish only, the machine operates at 60 strokes per minute, using 600 grit compound, and 150 strokes for each assembly. A Veeder Root counter and a Minneapolis Honeywell magnetic valve make the machine automatic. UAL designed unit.



Hydraulic Testing Cabinet at PAA

• An inexpensive medicine cabinet provides the base for this light, mobile unit for pressure testing, up to 5,000 psi., of hydraulic lines. Outfit consists of hydraulic hand pump, tank in rear for hydraulic fluid, gage registering in units of 100 psi. up to 5,000, connecting lines, and pressure coupling. Small gage on side rack is an air pressure paint-spray gage used to test oil separator valves. Incorporating a pressure reduction chamber with regulator giving a range up to 80 psi., it is connected to plant compressed air line. Unit was designed by A. P. Peria.

Every Flight To and From St. Louis is Cuno Protected

In an average day at Lambert-St. Louis Airport in Robertson, Missouri — 18 landings and take-offs by three airlines— *every single plane* was found equipped with Cuno "continuously cleanable" Filters.

Cuno-Chosen

BY MOST ENGINE AND AIRCRAFT MANUFACTURERS

Builders of today's aircraft have faith in the dependability of Cuno Filters for protecting fluid systems — engine and supercharger lubrication, as well as hydraulic control and glycol heating systems.

Since commercial aviation's earliest days, Cuno engineers have worked closely with aircraft designers — developed the first filters to provide positive, uninterrupted removal of sludge. Today, Cuno filters are accepted as "standard equipment" for almost *every* fluid-protection job on the modern plane.

Cuno's filtration-maintenance service stems directly from the widespread acceptance of "the filter that cleans itself in flight". Following through on its responsibility to safeguard vital fluids without interruption or delay . . . Cuno's maintenance and advisory staff, working closely with service depots, makes sure that all operating crews know the construction and maintenance facts about this simple compact, lightweight filter.

Fewer "Maintenance-Minutes" Per Hour of Operation

Cuno Filters can operate without attention for periods much longer than the longest flight — cleaning is quick and easy. There is nothing to remove or replace. The all-metal filter element is dependable — turning a handle rotates the filter discs past stationary cleaner blades which comb out imbedded as well as adherent solids Complete automatic cleaning — desirable for engine lube systems — is made possible by the tiny Cuno hydraulic motor which is mounted on the filter and is powered by the same oil it helps to clean. Occasional inspection and the removal of sludge from the filter sump are all the attention needed.

Cuno Engineering Corporation, 707 South Vine Street, Meriden, Connecticut

SOME TYPICAL INSTALLATIONS

ENGINE LUBE OIL: Cuno Auto-Klean strains full flow of engine lubricating oil. Filter built in as an integral part of engine — self-cleaning in flight — no external connections.

SUPERCHARGER LUBE OIL: Supercharger bearings are protected against oil borne particles by a Cuno Auto-Klean which filters oil taken from main engine system before passing it to the supercharger.

HYDRAULIC CONTROL SYSTEM: Cuno Auto-Klean, installed in high pressure line beyond the engine driven pump, prevents damage or clogging of working parts in hydraulic control system.

GLYCOL HEATING SYSTEM: Glycol—from storage tank —passes through exhaust heater and cabin heat exchangers to provide hot water and galley heat for cooking. Cuno Auto-Klean filters glycol at 270°F. — protects working parts, prevents accumulation on heat exchanger tubes.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

WORTHINGTON

AIRFIELD

"GRASS BLITZER"

Keeps Airfields in condition to "keep 'em flying"

Big Bombers need big airports. Today airports *are* big . . . 400 to 1500 acres; and the number of them is increasing steadily. These fields must be cut regularly, speedily and often to assure efficient take-off and landing conditions. Cutting develops the all-important, thick, dense turf . . . important because it:

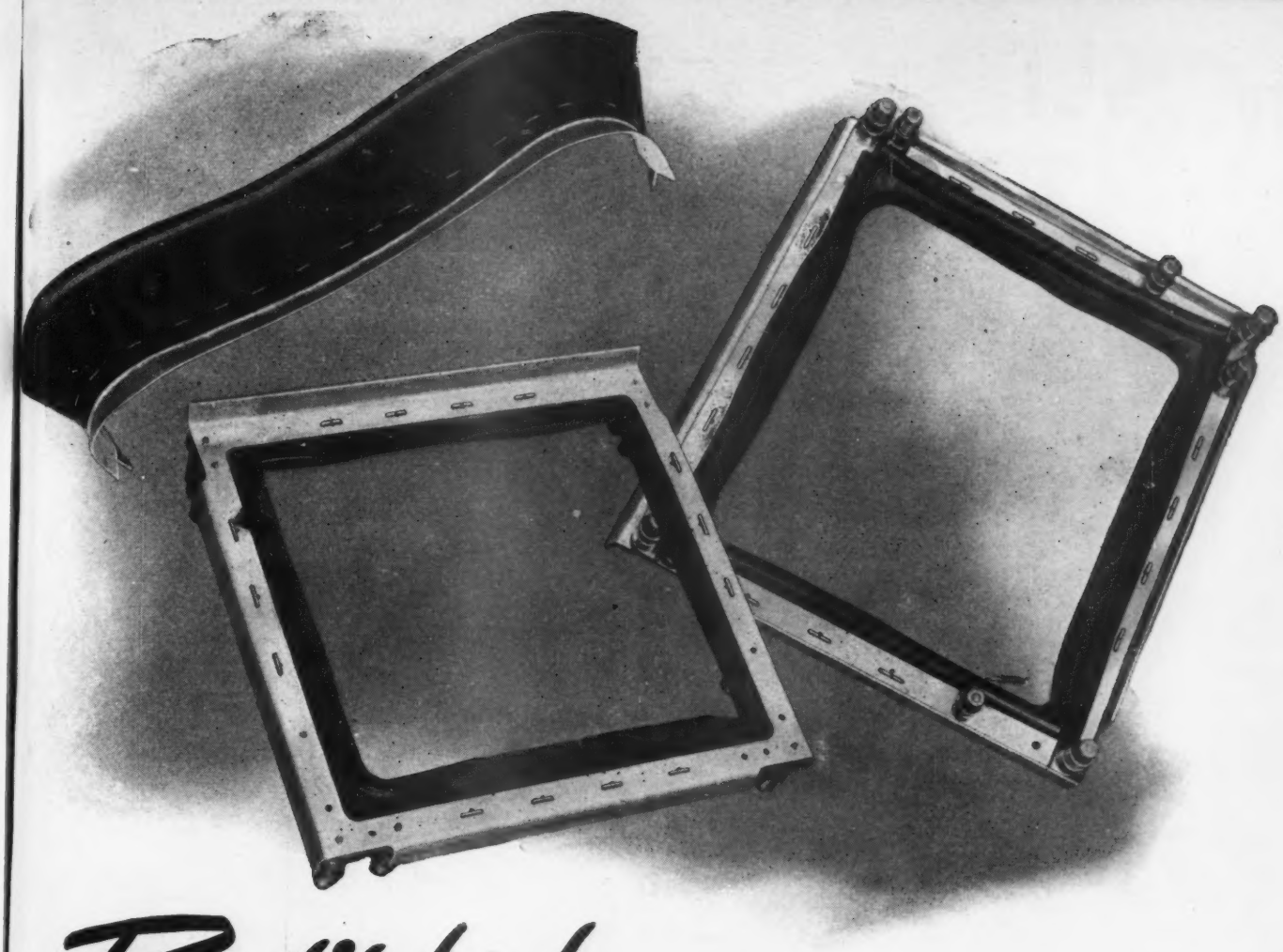
- **Keeps down dust which is a cause of too frequent plane motor tear-downs and parts replacements.**
- **Absorbs rainfall, preventing muddy areas and the danger of serious skids.**
- **Helps eliminate hazards of loose stone, gravel, etc., injuring propellers during motor revups, take-offs and landings.**
- **Helps eliminate wheel marks which can be photographed from as high as 30,000 feet.**

Backed by 30 years' experience in mowing and turf maintenance, Worthington engineers went to work and developed the largest capacity turf cutting machine in the world . . . the "Grass Blitzer." It was especially designed on a revolutionary new principle for airport conditions where speed and acreage-cut-per-day is of the utmost importance.

Today the Worthington "Grass Blitzer" stands head and shoulders above any ordinary mower in the field. It consists of a tractor and a 9-gang mowing unit which cuts a swath 21.2 feet wide at a speed of over 15 miles an hour. That means 35 acres cut per hour . . . 380 acres per 8-hour day; a cutting capacity that's over three times greater than any other make of tractor and gang mower now available.

If you have Airfield mowing and turf maintenance problems, consult us today.

WORTHINGTON MOWER CO.
Home Office: Stroudsburg, Pa.



Bostitched... for speed in assembly

For many years, Bostitch wire stitchers have speeded the fastening of a wide variety of non-brittle materials, including light metals.

Today, with the development of new stitching wire especially designed for aircraft parts manufacturing (such as *American Aircraft Stitching Wire*), Bostitching can be depended on for heavier work and precision standards.

Bostitch Aircraft-type Stitchers join metal parts and combinations of metal and other materials where applicable, at speeds at least double that of other fastening methods — in some cases, 8 to 10 times faster. Semi-skilled labor can be used, less inspection is required, floor space is saved.

The staple is formed from wire, and the legs are punched through the work (without pre-drilling), clinched flat on the under side to provide full bearing against the material. The hole is clean, and the fit between wire and perforation is close. Such materials as aluminum can be fastened without danger of fracture or warping, and the stitch can be accurately and quickly located.

Bostitching is being used for fastening such parts as ducts, trailing edges, fire walls, insulating strips, rubber gaskets, chutes, etc. Other fastening jobs in aircraft plants can be performed by other types of Bostitch machines. From a line of models unrivalled in its completeness, select the ones best fitted for your needs.

BOSTITCH

fastens it better, AND FASTER with wire

ALL TYPES OF STAPLES APPLIED BY MACHINES
ALL TYPES OF MACHINES FOR APPLYING STAPLES

BOSTITCH

(Boston Wire Stitcher Co.), 53 Blackmore St., East Greenwich, R. I. (Bostitch-Canada, Ltd., Montreal)

THE JOLT OF *THE THUNDERBOLT** HITS THE AXIS!

*REPUBLIC P-47
HIGH-ALTITUDE FIGHTER

REPUBLIC AVIATION

REPUBLIC AVIATION CORPORATION . . . FARMINGDALE, L. I., NEW YORK—EVANSVILLE, INDIANA

AIR MASTERY THROUGH REPUBLIC AVIATION ENGINEERING EXCELLENCE

Northwest Deliveries

By DAVID BAKER,
Assistant Editor, "Aviation"

MILITARY

Russia is not the only nation to lick the cold weather problem. How difficulties have been met and surmounted by the Ferry Command and the ATC in running the Alaska route is explained by the author, who flew north to "cover" their little publicized work.

DESTINATION — Alaska. Country — rugged. Preparation—well, that's an absorbing story in itself.

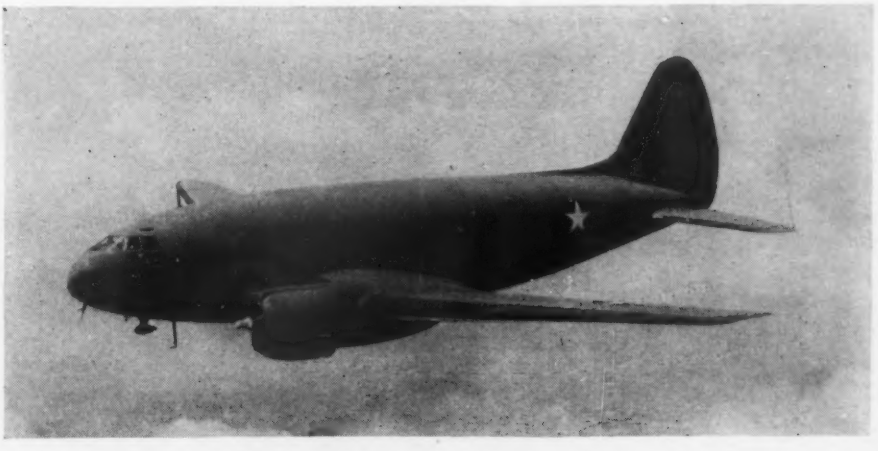
The Ferrying Group, with general headquarters in the U. S., is responsible for delivery of all military airplanes into Alaska, and works in conjunction with the Alaska Wing of the ATC stationed in Canada.

Before any ferry pilot leaves his base to fly the "northwest passage", there is a lot he has to learn, for in winter flying through this region a few scraps of knowledge and a bit of the right equipment may make all the difference between a warm live man and a very cold corpse.

Briefing of Alaska-bound pilots has grown to a substantial educational project carried out by carefully developed pictorial methods, backed up by personal case histories of men who have gone before. It is necessary to make this instruction graphic and forceful because of the short time available to spend on it—about two hours. Its urgency has been proved again and again by lives saved when craft were forced down and by a few that were not because instructions were not followed.

One story concerns a man who made a forced landing on a lake in a P-39. There was snow on the ice, so he pulled up his wheels and came in for a belly landing, which he made with little difficulty. But out alone in the wilds at 40 below, that's only the beginning. The next thing was to keep warm, dry, fed, and to stay by the plane so that he could be found when the airplane was spotted by rescuers. He followed instructions well, only he had a little difficulty in finding and getting at some of the emergency equipment in the plane. Principal lack was a screwdriver to open a compartment which would have yielded an axe, had he been able to get in. Another trouble was that he did not know just which items he would find where, due to lack of standard stowing practice, all of which instructive information was duly passed on to prevent repetition in the future.

The climax of the story comes several months after this pilot was rescued and safely returned—he was actually found stepping into a northbound delivery in "pinks" and short jacket, without any of the warm clothing which had once saved his life. Which shows why this information has to be driven home hard.

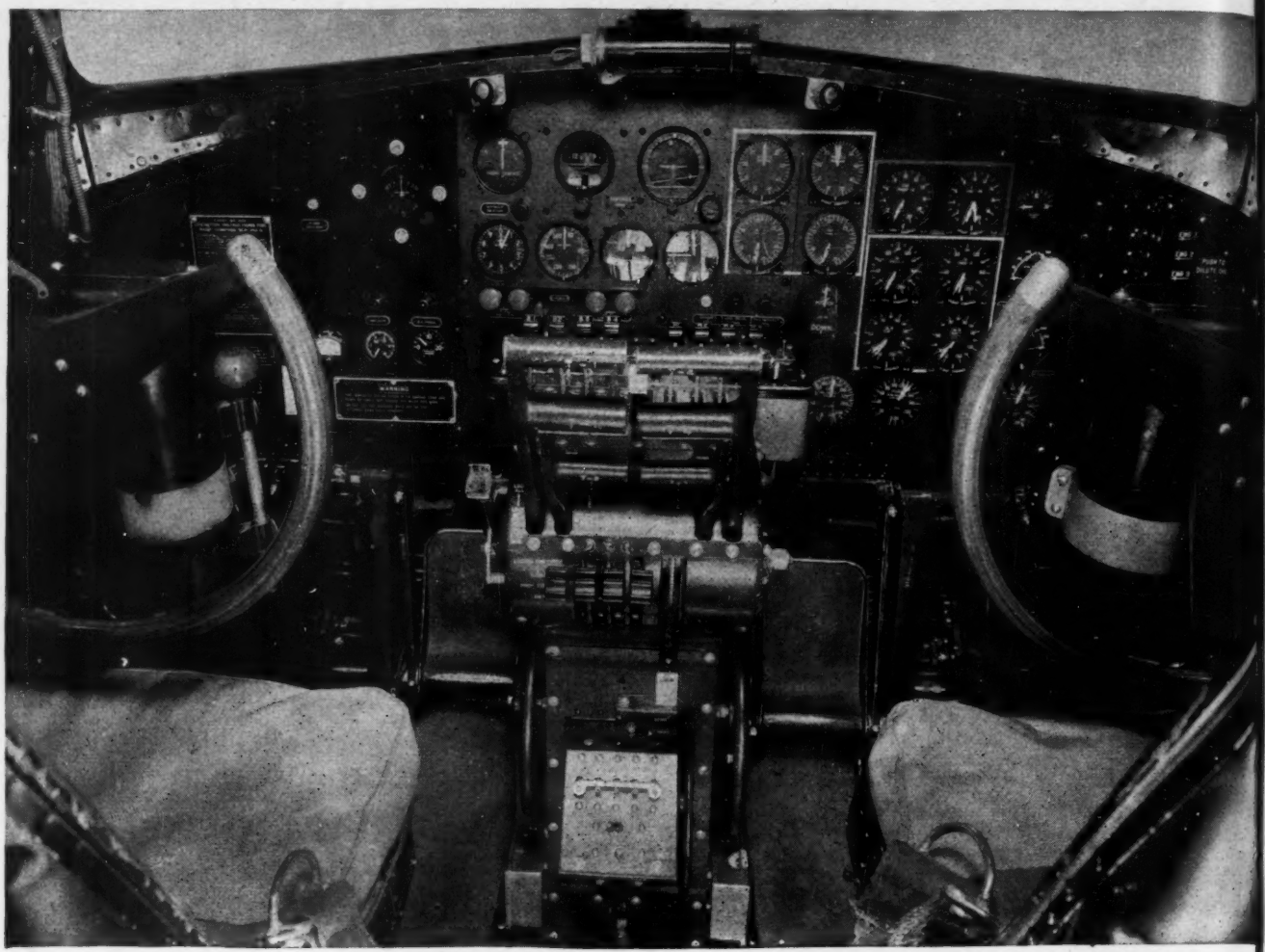


Curtiss "Commandos" have played a useful part in northwest transport, being used as cargo, personnel, and hospital ships. In conjunction with DC-3's, they have supplied men and materials for the Alaska Highway and returned ferry pilots to their bases.

Briefing starts with map instruction, and the first caution is not to count too closely on map accuracy as to just where a lake will be found, for this region has never been systematically surveyed in detail, and there's been no time to do it. Landmarks along the route are described by men who have flown it. Radio facilities are explained, along with the hours of operation of

Acme photo

This is what winter looks like in the Alaskan Islands. It's not so bad at base, but a pilot grounded alone only a few miles from help may have to be on his own for several days before assistance arrives.



The "Office" of a Flying Fortress

HERE'S WHAT the "office" of a Boeing Flying Fortress looks like.

Before the take-off, each of these instruments is painstakingly checked by the ground crew and reported "O.K." In flight the clock-like dials are watched, closely, by the pilots. For on the accurate functioning of these "clocks" may depend the lives of the bomber's crew.

This vital accuracy, in turn, is largely due to one mechanism: Ball bearings! For these mechanical miracles (and they are such) reduce friction to the vanishing point, keep mechanisms cool, postpone wear and maintain precise location of parts.

New Departure ball bearings, by the *tens of millions*, are used in ships, tanks, planes, guns, trucks. They are being manufactured on a round-the-clock schedule, in numbers which would have appeared *impossible* . . . before Pearl Harbor.

New Departure Division General Motors Corp., Bristol, Conn.

New Departure

BALL BEARINGS

Nothing Rolls Like a Ball

3162

Press Association, Inc.

Proper knowledge can keep planes operating in the worst of circumstances. Engine and wing covers are absolutely necessary to prevent ice and snow from adhering to surfaces.

various control towers. Single place craft always follow the Alaska Highway, first because avigational facilities in a fighter are not as complete as with a bomber; second, and most important, if they get in trouble and have to come down, they can be much more readily found and assisted if near the Highway. Since each pilot is alone, this is more important than with crews.

Larger ships may fly straighter courses between points, but all are instructed to follow the flight leader, and to keep him in sight at all times. It is easy to lose sight of a plane in sudden changes to bad visibility, and once lost in that country you are really lost. There is the classic example of three planes flying more or less blind, two apparently following the third to base. They arrived safely, but when they stepped out and talked it over, it appeared that nobody had been navigating. They had simply followed each other. It might not happen so well a second time.

Weather conditions are thoroughly reviewed, with the latest field conditions and location of emergency fields. The general information issued in the U. S. is made more specific upon arrival in Canada, with additions of recent local field conditions relating to surface, such as mud or snow and how much, changes in lighting, or any other variables.

The subject of proper clothing is perhaps most important of all. A man can live quite a while with little food, and if he can build a fire he can get water. But he can do nothing if he freezes. Keeping dry is of first importance in this respect. The best thing so far developed is the eiderdown suit, which is lighter and warmer than all others. Footwear is a great problem, for although warmth is comparatively easy to attain, there must be no sweating involved. The arctic mukluk seems still to be best, for it is warm but porous enough to keep feet dry.

Down sleeping bags are an absolute necessity. With the scant sleeping accommodations of a pursuit plane, one night in the sub-arctic open without one of these would be the last. Additional equipment consists of an axe, knife, firearm of some sort, and a small tent or shelter. Standard kits of this necessary equipment are made up and provided.

Procedure if forced down is shown by series of pictures in sequence of action, and moving pictures for this are in preparation. It goes much further than words in telling what to do and how to do it, to men who have probably had

(*Turn to page* 374)

Equipped with auxiliary tanks, many of these P-39's have flown over the "Highway" to aid our Russian ally. Fighter pilots are told to follow the Road to be within closer reach in case of accident.

Here's the inside story — of the wing center of a BT9

Reproduced from original drawn with Typhonite Eldorado HB.

We will be glad to send you a blueprint of this drawing, if requested within 30 days of publication. You'll find an exceptional clarity in the blueprint. It's due to the use of Dixon's Eldorado drawing pencils containing Typhonite leads.

North American Aviation, Inc. has produced more than 10,000 training planes for use by student pilots. Not just American pilots, either, but air cadets of the United Nations.

Shown above is a detailed drawing of a wing center section. The flaps, in retracted position, are shown at A. Fuel tanks are carried in the recess, held in place by straps B. Note the fuel lines, C. Openings D are inspection plates to facilitate maintenance. Landing gear fittings are at E.

With ***Typhonite* ELDORADO you can depend upon every line's having the exact amount of density required for perfect blueprints.

Why not try Dixon's *Typhonite* ELDORADO pencils on your next job? It's more than likely you'll discover that your technique seems to have improved!

Pencil Sales Department 61-J7
Joseph Dixon Crucible Company
Jersey City, New Jersey

*In the Typhonite process a new form of natural graphite—Typhonite—is created, its particles of controlled smallness and evenness of size, scientifically ascertained as best for drawing pencil leads.

TYPHONITE ELDORADO

All Photographs by Sovfoto

MILITARY

This initial picture of Russian Air Force training base shows primary squadron members lined up for inspection before planes. Except for tandem seating and rudder shape, planes greatly resemble American-built Kinner *Sportster* of early 30's.

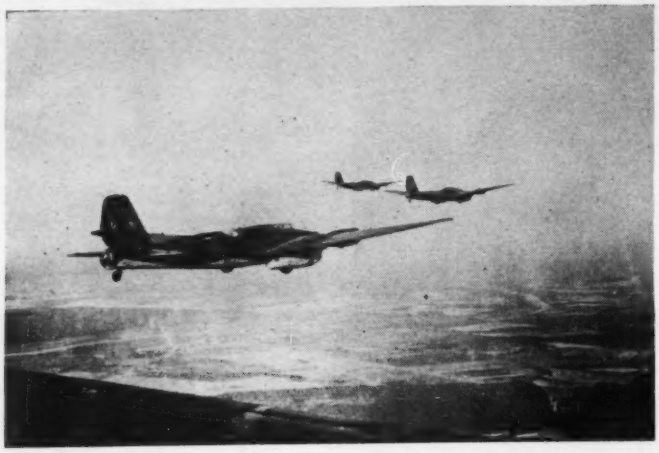
Soviet Air Force Using Wide Range of Aircraft Types

First training photos show former fighter craft adapted to advanced instruction. Meanwhile, operational types indicate thoroughly modern design and construction methods.

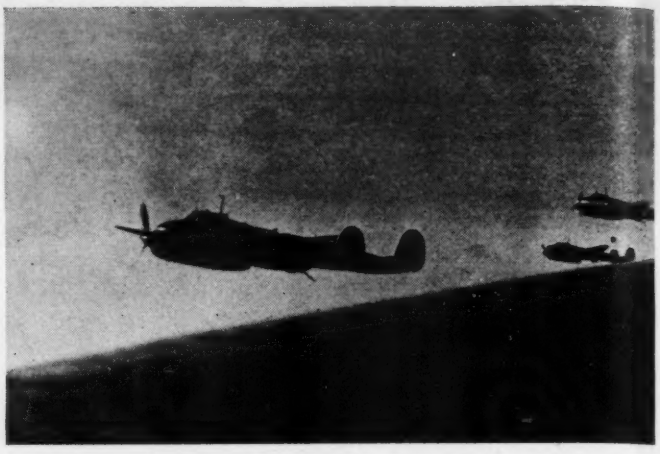
Advanced Red Air Force flying schools use the I-16B *Super Mosca*, a two-place version of famed Mosca which was utilized extensively by Loyalists during Spanish Civil War. Original I-16, powered by 630-hp. M-25 engine, had top speed of 280 mph.

Maj. B N. Eremin signs letter of thanks to collective farm group which purchased fighter plane (apparently LAAG-1) for Red Air Force. Maj. Eremin is credited with 7 enemy planes destroyed in single combat and 14 brought down during group battles. Note size of cannon (foreground) mounted in wing.

Maj. Eremin takes off from unmarked air base on first operational flight in aforementioned fighter plane bought by collective farm.



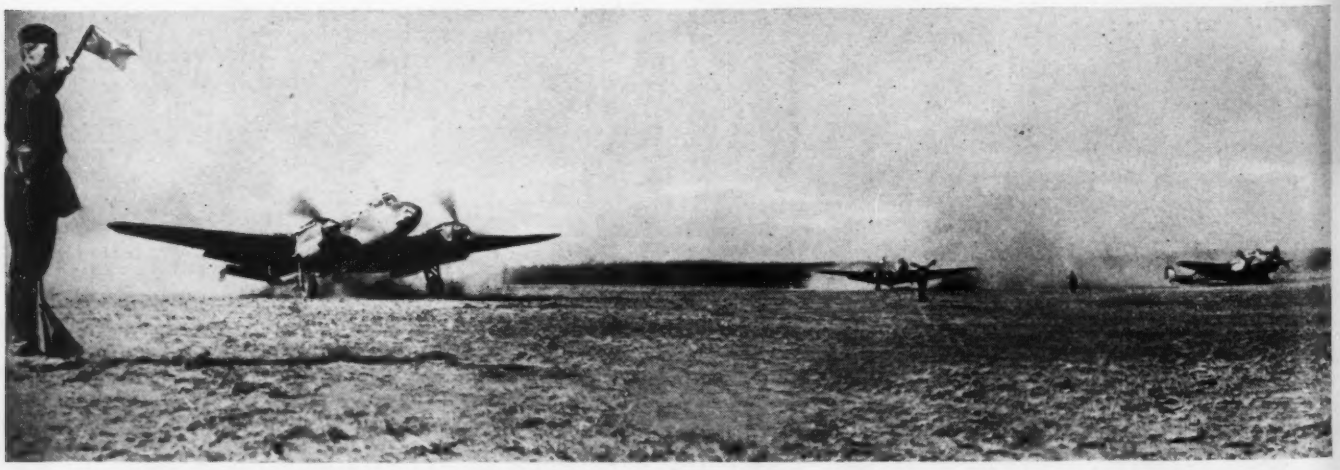
First flight photo of DB-7 (sometimes called TB-7) long-range four-engine bombers. They have 8,000-lb. bomb capacity and are reported to be type participating on recent raids against Germany. This is craft in which Foreign Commissar Molotov flew from Moscow to London and Washington. Note gun turret in rear of inboard engine nacelle, which also houses retractable landing gear and carries radiators for two engines.



Squadron of YAK-4's, twin-engine reconnaissance bombers, heads toward setting sun on bombing mission. Designed by Ilyuchin, craft is powered by two liquid cooled Hispano-Suisa engines of 1,150 hp., has top speed of 315 mph. Construction embodies use of both metal and plywood, a practice followed extensively by Russian designers. Note heavy calibre machine gun protruding aft from bottom of fuselage, conforming to modern armament requirements.

Red Air Force bomber crews at temporary headquarters being briefed just before setting out on mission against Nazis in Western Russia. Note panels of aircraft photographs on wall behind briefing officer. They are used as constant reminders and as aids for recognizing type of planes—both friendly and enemy—likely to be encountered in that theater of operations. Note also rather wide range of ages represented by combat crews shown.

Russian pilots eagerly inspect newly-arrived American built Douglas A-20's, large numbers of which have been delivered to Soviets. A-20 is one of most highly regarded of United States planes now being used by Soviets. Unofficial reports say one of Red Air Force pilots' favorite tricks is to take off, retract wheels, and immediately go into slow roll. (For additional details on Russian planes, see pages 221-227 and 259, Feb. AVIATION.)



At signal from ground operations officer at left, crews start take-off run in PE-2's, three-place combination bomber and ground attack craft. M-105 Hispano Suiza 1,300-hp. engines give PE-2 better than 300-mph. top speed. "Airport" is merely large cleared field without runways or extensive building facilities, with trees surrounding base providing cover for plane dispersal.

F.O.B. Tokyo

CARGOES of destruction for Tojo, delivered by Brewster dive bombers with Curtiss Electric Propellers, will make the strong arm of the Navy felt at new long ranges. Thus will our two-ocean fleet extend its strength far beyond its doubled tonnage.

ELECTRIC
CURTISS
PROPELLERS

CUSHIONING *Flagships* FOR EASY LANDINGS

PREPARING big airliners for easy landings requires careful attention to many mechanical details. For example, it is most important that a constant and proper pressure be maintained on the oleo struts of the landing gears—and on the American Airlines' "Flagships," an Airco gas regulator does the job accurately.

The same method is used to control the air pressure which balances the hydraulic system for operating landing flap brakes and retractable landing gear—and on many airlines Airco nitrogen is the gas used for this purpose.

These are just two of a large number of operations which link Air Reduction with the aviation industry. For instance, Airco oxygen regulators aid stratosphere flying...Airco and Wilson electric welding equipment speed construction of sturdy jigs and fixtures in airplane factories... Airco gas welding and cutting torches play leading parts in the manufacture of numerous aircraft parts.

Through these products, and through its research and Field Engineering Service, Air Reduction is helping to facilitate aircraft operation, production, and maintenance. For detailed information or technical aid, write your nearest Air Reduction office.

AIR REDUCTION

General Offices:

60 E. 42nd STREET, NEW YORK 17, N. Y.

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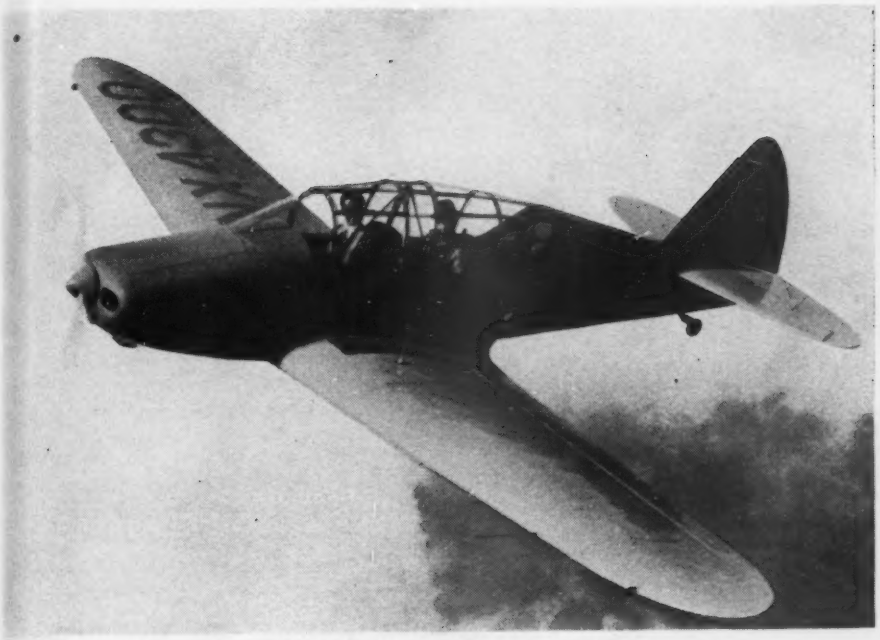
IDLE CYLINDERS ARE PRODUCTION SLACKERS: KEEP 'EM ROLLING FOR VICTORY!



FLYING EQUIPMENT

This new Piper trainer is powered by 130-hp. Franklin 6, it has a top speed of over 150 mph., cruises at better than 135, and has cruising range of 700 mi. Fuselage is of steel tubular construction; cantilever wing is plywood, fabric covered.

Piper Enters Low-Wing Trainer Field

New craft, created by a former flight instructor, has many features unique in light plane field. It was designed for Army and Navy primary or WTS advanced work—with an eye on postwar training operations.

TO MEET present-day demands for Army or Navy primary and WTS advanced training, as well as to aid postwar flight instructors, Piper Aircraft Corp. has developed a new two-place, low-wing trainer radically different from previous types built by the company.

Powered by a 6-cylinder 130-hp. Franklin engine, the new trainer is reported to cruise at better than 135 mph. and to fly top-speed at more than 150 mph., yet land at less than 50.

Non-strategic material has been used wherever possible, and special care was given in design to assure ease of maintenance and to secure greatest length of service with a minimum of time lost for inspection and overhaul.

Fuselage of the prototype is of conventional, steel tubular Warren truss construction, with turn-over structure an integral unit between front and rear cockpits. Firewall bulkhead includes fittings for attaching the engine mount by four bolts. Wood stringers are used; turtleback is of plywood. Production models will have removable plywood side panels running aft of the rear cockpit to facilitate fuselage inspection. Fuselage is fabric covered with exception of removable inspection panels extending from the firewall to the front cockpit.

Cockpit cover has a top section hinging on the right side, with sliding windows on each side; and with the top section secured the plane can be flown with windows either up or down. Access to the plane is gained by sliding the left window down and opening the top section.

The full cantilever wing has built-up box-type monospar and wood ribs, comprised of center section and two outer panels joining outboard of the landing gear attachment. Flap brackets and

(*Turn to page* 361)

Specifications and Performance Data

Span	34 ft.
Length	22 ft. 10 in.
Height	6 ft. 6 in.
Wing area	164 sq. ft.
Wing loading	12.2 lb. sq. ft.
Power loading	15.4 lb. sq. ft.
Aileron area	15.4 sq. ft.
Flap area	13.8 sq. ft.
Stabilizer area	15.2 sq. ft.
Elevator area	12.2 sq. ft.
Fin area	5.9 sq. ft.
Rudder area	5.8 sq. ft.
Fuel capacity	40 gal.
Gross weight	2,000 lb.
Empty weight	1,325 lb.
Useful load	675 lb.
Maximum speed	Over 150 mph.
Cruising speed	Over 135 mph.
Cruising range	700 mi.
Landing speed	Under 50 mph.
Rate of climb	750–1,000 ft./min.
Power plant	Franklin 6AC298 horizontally opposed, 130 hp.

Piper's new trainer has all controls and instruments in exactly same location in both front and rear cockpits. Auxiliary panel can be added to rear cockpit, above standard panel on turn-over structure, for instrument and night flight training. Retractable oleo spring landing gear has spread of 100 in. Plane has span of 34 ft., length of 22 ft. 10 in., and height of 6 ft. 6 in.

Buy War Bonds and Stamps

Another Fortress Is Hatched

A mammoth door is raised. Without fanfare, another Boeing Fortress is rolled out—ready to fly!

Looming huge and mysterious in the half-twilight, the Fortress beneath its trim, classic lines sheathes interior structures and installations that are both durable and complex.

Despite the many difficulties entailed in building so complicated a weapon, Boeing is able to hatch out Flying Fortresses* in constantly accelerating volume, because it has reduced even the most involved procedures to simple, accurate operations which can be learned quickly. This means manufacturing planning of the highest order.

Each part, each function, each assembly (and they total thousands) had to be arranged and tooled. Boeing, for example, developed more than 100,000 *special* tools to do the job.

One result is that Boeing's output is the greatest of any aircraft manufacturer—per man, per machine, per unit of floor space. Today, Boeing is building Flying Fortresses at a rate *eight times greater* than the month before Pearl Harbor.

Further, the results of Boeing's planning are, in turn, helping other companies to speed up America's aircraft production. For, under the BDV agreement, Boeing has made its plans and specifications available to both Douglas and Vega which also build Boeing Flying Fortresses.

• • •

Once peace is won, you can look to Boeing's research, design, engineering and manufacturing genius to bring you many a new and interesting product . . . with the sure knowledge that if it's "Built by Boeing" it's bound to be good.

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS

Close tolerance forgings can Make time for your assembly line

● Close tolerance forgings usually require *less time to machine and finish* and therefore indirectly increase the capacity of both machines and men employed on finishing forgings. Close tolerances are, in part, the result of knowing how to match forging hammers and the skills of forging craftsmen to the requirements of each forging job. Forging to close tolerances is a standard practice in T & W Forging Shops. T & W forgings, formed to close tolerances, can *make time for your machining line* in the production of aircraft units and armaments at a faster rate. A T & W Forging Engineer can point out many other important advantages which T & W forgings offer.

Forging to close tolerances is the standard practice in T & W Forge Shops where the skill of forging craftsmen and the performance of hammers in a wide range of capacities are known to management.

FORGINGS

USUALLY COST LESS
at the Point of Assembly

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STEEL FORGING CORPORATION • ALLIANCE, O.

SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, INDIANAPOLIS, DETROIT AND CLEVELAND

The "Northrop group" of Americans doesn't fool around

It is twenty-five minutes to midnight. Toward their jobs walk some of the thousands of our home front fighters, men and women whose work tonight will fly by tomorrow's dawn

THEY ARE filtering in to take over the graveyard shift. Inside, the swingshift is working. Mechanical "routers" whine through metal—you can hear the din of rivet guns. At quarter to midnight an electric whistle will sound and the swingshift will lay down their tools, but at that moment the men and women you see here will be at their places, working.

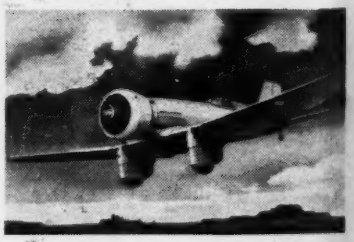
There is no waste interval between shifts in this plant. *The Northrop group of men and women doesn't fool around.*

Men known wherever planes are flown lead this Northrop group. Around them they have gathered many kinds of engineers and production men . . . group leaders . . . men and women who have become skilled at riveting, welding, sheet metal fabricating . . . all the thousands of earnest, able people it takes to whip dead metal into living warbirds.

Folks come here from many places, out of many walks of life—and stick! They stick to this group that doesn't like slowdowns or lost time. Why is that?

Maybe the Northrop group works together because nobody around here has any use for red tape or pride of position. Maybe because a person working on Northrop's part of the production battlefront *knows* he's doing a real job of fighting the Axis.

For in the over-all plan of U.S. plane production, vitally important tasks have been given to the Northrop group. Tasks that have placed many fighting warplanes on the battlefronts of the world. Tasks that challenge the best in any man or woman.



A NORTHROP "FIRST" IN 1934

Coast-to-coast with air mail in 11 hours 31 minutes

The airplane above is a Northrop "Gamma" designed and built ten years ago by the Northrop group.

On May 14, 1934, Transcontinental & Western Air flew this single-motored ship, fully loaded with mail, from Burbank, California to Newark, N. J. in just 11 hours, 31 minutes—five hours faster than today's scheduled air mail.

Other Northrop "Gammas" sold to China were the first attack bombers. Today Northrop "Gammas" are still serving the United Nations actively on at least two continents.

NORTHROP AIRCRAFT, Inc.

NORTHROP FIELD, HAWTHORNE, CALIFORNIA

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

CIVIL OPERATION AND TRAINING

"Junior CAP" Aids Young Leaders

By GENE SLACK

Civil Air Patrol Cadet program gives practical, advanced aviation and military training to outstanding high school students.

WHILE EDUCATORS and experts have shaped plans for universal aviation education, the Civil Air Patrol in its own quiet way today has underway a program which already is exerting an influence far beyond the scale of its operations.

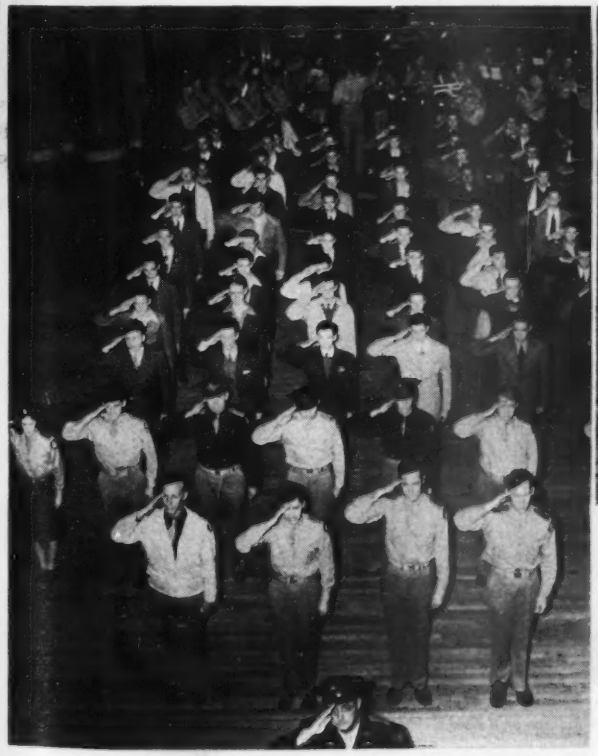
Not that CAP itself is any pint-size undertaking. More than 75,000 citizens with aviation skill have been organized along with their planes at more than 1,000 airports throughout the country. They are flying coastal patrol, towing targets for the Army, furnishing thousands of specially trained men to the armed services, and doing all the jobs in which little planes can help fight a war.

St. Paul Pioneer-Press photo

Practical aviation training for outstanding high school juniors and seniors is provided in Civil Air Patrol Cadet program. Here, Lt. Fred Murphy, CAP, gives engine instruction to cadets of St. Paul, Minn., squadron.

In the CAP Cadet program, the Patrol is now engaged in making a junior copy of itself, complete in almost every particular. Each CAP unit can form a counterpart unit of cadets; each member of CAP is authorized to sponsor one cadet recruit. It is as simple as that.

Building on the parent organization, CAPC has cost the Federal Treasury to date only as much as it costs to mimeograph a few thousand copies of a one-



Under CAP Cadet program, each CAP senior member may sponsor a cadet, and in some larger cities CAP squadrons have sponsored outstanding pre-flight students selected for advanced training by their school teachers. Left, Atlanta, Ga., cadets at induction with Civil Air Patrol officers.

CAP uniforms are almost like those of senior members. But the youths find that "glamor of uniforms" isn't the proposition—for like the parent organization there is plenty of work and strict discipline, as shown by radio students receiving instruction from one of their elders in the Minneapolis Group.

DAUNTLESS . . . Again and Again!

HAVING BORNE the brunt of the fighting in the Pacific, Douglas Dauntless Dive Bombers have blasted the Axis out of Africa. A Rear Admiral of the U. S. Navy says: *"Your entire organization has reason to be proud of the performance of SB-Ds (Dauntless) which have alone sunk more combatant tonnage than all other arms."* DOUGLAS AIRCRAFT COMPANY, Inc., Santa Monica, Calif. • Long Beach, El Segundo, Tulsa, Oklahoma City, Chicago.

DOUGLAS

Largest Builder of Combat, Cargo and Transport Aircraft

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

• *Until recently aviation editor of the Nashville* Tennessean, *Miss Slack became a member of the Women's Air Ferrying Service shortly after completing this story. A private pilot and former lieutenant in the Nashville Civil Air Patrol Group, Miss Slack saw the CAP Cadet idea pioneered in the Tennessee school system, and she was closely connected with inauguration of the Cadet program in Nashville.*

page directive and a one-page application blank, print a few more thousand membership cards, and mail them to the CAP Wings in 48 states.

Because the plan of CAP is to try to do a small job well, rather than to extend beyond the capacity of its volunteer system, the membership of CAPC at any one time will be limited to a few tens of thousands while the aviation education programs in the schools are intended to teach the rudiments of flight to millions.

The important difference is that CAPC has the advantage of being under the direct supervision of seasoned airmen—the remaining civilian pilots not in the armed services or in the work of military training.

For years these senior CAP members have been studying and applying aerodynamics, meteorology, avigation, radio, and aircraft mechanics. Since Jan., 1942, they have been acquiring additional knowledge of photography, code, first aid, military courtesy and discipline, air raid warden techniques, gas and fire control, and pistol shooting. They are now fully prepared to instruct cadets in these subjects and to see that they get a practical application of preflight aeronautics.

And are the youngsters interested? Judge for yourself. Senior students in the last two years of high school who have good scholastic standings, who are physically fit, native-born Americans, and whose parents meet the citizenship requirement of CAP, have swamped headquarters throughout the country with applications. In the Connecticut Wing the cadet applications so far exceeded the number of CAP members that, in order to maintain the 1-to-1 ratio, Squadrons in the state recruited more CAP members.

Methods of enrollment have varied. Where there have been small squadrons in small communities, it has been easy to have individual CAP members sponsor a cadet each. In larger cities, however, the individual method was not practical and it has been better to have the pre-flight teachers select their outstanding students.

Tennessee had the jump on other states both as to method of choosing cadets and as to applicants' knowledge of aeronautics. This is true because, preceding both the "V" program and the cadets, the Tennessee Bureau of Aeronautics installed an elementary aviation course and had 10,000 model airplane kits in the elementary schools at the beginning of the fall term of 1941.

(*Turn to page* 347)

St. Paul Pioneer-Press photo

Though they don't get actual flight training, CAPC members work on and around real aircraft. Their well rounded training includes first aid instruction such as that being given these St. Paul cadets.

CAP Cadet training, such as this work in meteorology, has already helped win quick promotions for young men who have gone into the armed forces.

If One Part of the Finishing Picture is Missing . . .

Scheduling a Plywood Aircraft Finish to include all the essential qualities is like assembling a jigsaw puzzle. If one quality is missing, the whole is incomplete. A system of finishing must possess all the essential qualities to an adequate degree to give satisfactory, lasting protection. TUF-ON systems are complete. They not only include all essential qualities but the wide range of TUF-ON coatings permits scheduling to meet any desired quality emphasis. Write and tell us of your requirements.

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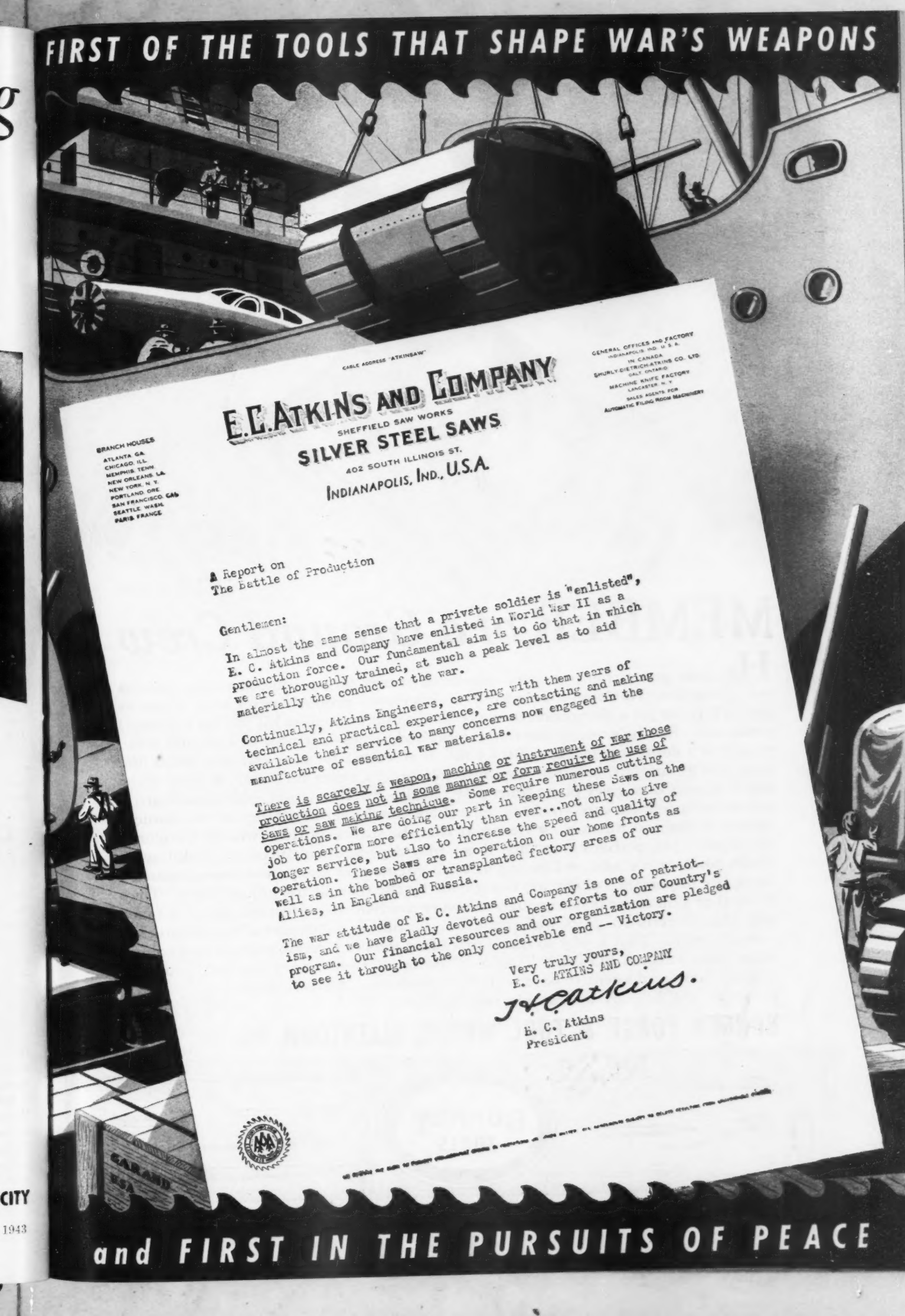
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A Report on
The Battle of Production
Gentlemen:
In almost the same sense that a private soldier is "enlisted", E. C. Atkins and Company have enlisted in World War II as a production force. Our fundamental aim is to do that in which we are thoroughly trained, at such a peak level as to aid materially the conduct of the war.
Continually, Atkins Engineers, carrying with them years of technical and practical experience, are contacting and making available their service to many concerns now engaged in the manufacture of essential war materials.
There is scarcely a weapon, machine or instrument of war whose production does not in some manner or form require the use of Saws or saw making technique. Some require numerous cutting operations. We are doing our part in keeping these Saws on the job to perform more efficiently than ever...not only to give longer service, but also to increase the speed and quality of operation. These Saws are in operation on our home fronts as well as in the bombed or transplanted factory areas of our Allies, in England and Russia.
The war attitude of E. C. Atkins and Company is one of patriotism, and we have gladly devoted our best efforts to our Country's program. Our financial resources and our organization are pledged to see it through to the only conceivable end — Victory.
Very truly yours,
E. C. ATKINS AND COMPANY
J. C. Atkins
E. C. Atkins
President
and FIRST IN THE PURSUITS OF PEACE

MEMBER *of a Ground Crew*

HE never gets a chance to drop bombs on enemy targets—knock enemy fighters out of the sky. He doesn't wear wings on his chest—probably never will. Chances are he'll never get a decoration or make the headlines because his job isn't a glamorous one. But he's one of the war's unpraised heroes—member of a ground crew. • *And he's doing a whale of a* BIG JOB! If it wasn't for him and thousands like him, the glamorous, headline-catching jobs might never be done. • After every flight he goes over every plane from nose to tail—checks engines, plane and instruments with infinite care—making sure there can be no possibility of mechanical failure on the next mission. • He knows that the success of those who do the glamorous jobs—yes, perhaps even their lives—may depend upon the care and skill with which he does his job. • Leading aircraft engine and equipment manufacturers know the importance of the job being done by the man in the ground crew. They know that skill alone is not enough to insure mechanical perfection—know it takes skill plus properly designed, well-made tools for him to do his part of the job quickly—easily—well. That's why so many manufacturers of aircraft engines and equipment have selected BONNEY TOOLS—"the finest that money can buy"—as the original tool equipment to send with their products. • His skill plus BONNEY TOOLS—an unbeatable combination.

BONNEY FORGE & TOOL WORKS, ALLENTOWN, PA.

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Products & Practices

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Technical Publications.....1
Contributions to technical literature by staff members of Battelle Memorial Institute, Columbus, Ohio, during 1941 and 1942, plus more than 500 publications and patents for prior years, have been bibliographed in a catalog published by this industrial research organization.

Re Foreman 2
Calling the foreman the "key man" in a plant, booklet issued by National Assn. of Manufacturers, New York City, presents sections on his training and education, also management-supervisory relations.

Cutting Fluids.....3
SAE steel numbering system, chemical compositions charts, and machinability index are given in booklet, *Cutting Fluids*, prepared for metal workers by Tide Water Associated Oil Co., New York City.

Electric Catalog 4
American Phenolic Corp., Chicago, has prepared loose-leaf technical catalog of its AN fittings, connectors, and cables.

Sheet Metal Work.....5
Sheet metal and metal-forming machines are among types of shop equipment pictured with tabular data and specifications in illustrated catalog from Peck, Stow & Wilcox, Southington, Conn.

Industrial Ovens.....6
Diagrams and photos in catalog from Lanly Co., Cleveland, show features of firm's line of ovens for industry.

Synthetic Rubber 7
Development, properties, manufacture, and uses of synthetic rubber are traced in lay language in *The Five Commercial Types of Synthetic Rubber*, booklet issued by U. S. Rubber Co., New York City.

Air-Cooled Transformers 8
Power Where You Need It, bulletin released by Acme Electric & Mfg. Co., Cuba, N. Y., outlines and gives examples of applications of air-cooled transformers.

Tank Lining 9
Use of Koroseal, synthetic elastic plasticized polyvinyl chloride, as chemical resistant tank lining is analyzed in Catalog Section 9028 from B. F. Goodrich Co., Akron.

Hydraulic Hoist.....10
Federal Aircraft Works, Minneapolis, has issued bulletin of illustrations and specifications of its portable hydraulic overhead hoists for airplane service and maintenance.

Test Chamber 11
Broadside from American Coils Co., Newark, N. J., shows features and specifications of company's high and low temperature test chamber with automatic humidity control.

Wood Preservation 12
Laucks Wood Preservatives, brochure prepared by I. F. Laucks, Seattle, has charts on preserving solutions and describes methods for protection from moisture and fungi decay.

Flight Position Jacks.....13
Malabar Machine Co., Los Angeles, has prepared broadsides on its tail and leveling jacks for putting planes in flight position to check instruments.

Wear Gage 14
For measuring the amount of material removed from metallic surfaces by wear, abrasion, grinding, honing, and lapping, American Instrument Co., Silver Spring, Md., is producing gage, described in Bulletin 2109, with range of .000015 in. to .0014 in.

Service Stand 15
Folding service stand, made by Wolfe & Mann, Baltimore, is shown in various working positions about aircraft in folder prepared by the company.

Spring Manual 16
Mid-West Spring Mfg. Co., Chicago, has issued manual with spring-design and engineering formulas, diagrams, and tables for compression, extension, and torsion.

Welding Chart 17
Hot Tips on Arc Welding is name of chart prepared by Ergolyte Manufacturing, Philadelphia. It lists do's and don't's for safety, speed, and economy in welding.

Treating Furnaces 18
Bulletin 140 from Lindberg Engineering Co., Chicago, has photos and sketches on application of firm's furnaces for heat treatment of aluminum, magnesium, and their alloys.

Tubing Data 19
Purchasing data, specifications, and definitions are presented in outline form in *Steel Tubing for Aircraft Use*, booklet prepared by Ohio Seamless Tube Co., Shelby, Ohio.

Fire Extinguishers 20
Two charts, compiled by American-LaFrance-Foamite Corp., Elmira, N. Y., tabulate characteristics, methods of operation, capacity, range of stream, and uses of all types of fire extinguishers.

Indium Bibliography 21
Annotated 1941-42 supplement to the

* AVIATION READER'S SERVICE JULY
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Please send me additional information according to key numbers circled.

INFORMATION TIPS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51

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NAME..... TITLE.....

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ADDRESS.....

bibliography of indium has sections on qualitative and quantitative analyses of this element, occurrence and extraction, various physical and chemical properties, alloys, and miscellaneous information. Work was compiled by Maria Thompson Ludwick for Indium Corp. of America, Utica, N. Y.

Wood in War 22

Available to companies doing war work, illustrated book issued by Kay Displays, New York City, is titled, *Wood and Its Place in the War Effort.*

Wire Stripper 23

"Speedex" wire stripper made by Wood Specialty Mfg. Co., Rockford, Ill., for removing insulation is illustrated in broadside from the manufacturer.

X-Ray Identification 24

Circular, *Radiographic Identification,* prepared by H. W. Knight & Son, Seneca Falls, N. Y., shows use of lead figures and letters within field of the film for record-keeping purposes.

Amplidyne 25

In non-technical booklet of both text and engineering data, General Electric Co., Schenectady, N. Y., has explained the operation and uses of the amplidyne "which has a place wherever an electric signal can express the need for a change in process."

Gas Systems 26

Installations of Algas Units for converting liquefied petroleum gases for stand-by or regular industrial use are pictured in bulletin from American Liquid Gas Corp., Los Angeles.

Milling Catalogs 27

Principle of "planetary" milling of cylindrical parts up to 8 in. dia. on one machine produced by Plan-O-Mill Corp., Hazel Park, Mich., and larger pieces on another model, are explained in two catalogs from company giving tables of specifications, illustrating models, and describing their features.

Heating Units 28

Van Norman Machine Tool Co., Springfield, Mass., has prepared folder telling the story of induction heating and showing the principles and applications of the units.

Broach Sharpening 29

Bulletin CS1-43, from Colonial Broach Co., Detroit, supplies information on machine for sharpening round and flat broaches, sizes handled, and set-up methods.

Aircraft Instruments 30

Construction, Maintenance, and Repair of Aircraft Instruments, a paper by J. A. Gordon, has been reprinted in booklet form from the British *Horological Journal* and is being distributed by Henry Paulson & Co., Chicago.

Zinc Plating 31

Still and barrel plating with three precleaners produced by Turco Products, Los Angeles, are covered in company's technical report on bright zinc plating as a substitute for cadmium plating.

Apprentice Training 32

War and peacetime skilled-trades training and nine years' results of a plant apprenticeship system are described in pamphlet, *Training Apprentices for War and Postwar Work,* reprinted from McGraw-Hill's *Factory Management and Maintenance* magazine by War Manpower Commission.

Corrosion Resistors 33

Booklet prepared by Protective Coatings, Detroit, contains specifications of the Tocol line of tank linings and coatings to resist corrosion.

Business Bulletins 34

Thirty-seven business reports available from George S. May Business Foundation, Chicago, are listed in organization's Bulletin 8.

Safety Savings 35

Mine Safety Appliances Co., Pittsburgh, is distributing handbook illustrating and describing ways of increasing life of such personal-safety equipment as hats, clothing, gas masks, and respirators.

Tool Catalog 36

Three sections of revised price catalog issued by McKenna Metals Co., Latrobe, Pa., cover standard tools and typical nonstandard tools and give general information and suggestions on use of tools.

Portable Crane 37

Folder prepared by Yale & Towne Mfg., Philadelphia, points out features and details of twin-unit crane incorporating low elevating platform truck of 2,000 lb. capacity.

Welding, Brazing Fluxes 38

Superior Flux Co., Cleveland, has issued broadsides on characteristics and uses of its fluxes for brazing and silver soldering all metals except aluminum, and for welding stainless steel and Monel, Inconel, and aluminum and its alloys.

Tubing Data 39

Bulletin 443 lists mechanical, physical, and chemical properties of 25 metals being used in production of tapered, formed, and specially shaped tubes by Summerill Tubing Co., Bridgeport, Pa.

Welding News 40

Hobart Bros., Troy, Ohio, has issued notes and comments on welding practices in a paper titled *Arc Welding News,* available to interested parties wishing to be entered on the mailing list.

Parts Cleaning 41

Folder prepared by L & R Mfg. Co., Newark, N. J., gives questions and answers on use of firm's precision cleaning machines and solutions which can be used on instruments, cylinders, gears, bearings, and hydraulic equipment.

Plywood Tester 42

New tensile tester for veneer and thin plywood is described in folder from Streeter-Amet Co., Chicago.

Saving Air 43

Factory posters, prepared by Ingersoll-Rand Co., New York City, on economy in the use of compressed air, illustrate advantages of automatic blow guns, prevention of leaks, and protection and mending of hose.

Welding Booklet 44

To help instruct workers on how to prolong the life of their oxy-acetylene welding and cutting equipment, International Acetylene Assn., New York City, has issued pocket-sized *Handbook for the Welding and Cutting Operator.*

Finish Specifications 45

Testor Chemical Co., Rockford, Ill., has compiled file-folder size data sheets on laboratory, production, and application details of aircraft finishes, lacquers, and enamels meeting AN specifications.

Coated Abrasives 46

Blue Print for Faster, Better Production with New Coated Abrasives has been prepared with illustrations by Behr-Manning, Troy, N. Y., which also announces a technical service on metal finishing and polishing problems.

Magnesium Production 47

Information on the processes of producing magnesium are contained in a pamphlet, *Magnesium Scrap Book,* prepared by Fisher Furnace Co., Chicago.

Tapping Troubles 48

Third in a series of folders from Greenfield Tap & Die Corp., Greenfield, Mass., on proper use of taps is titled, *Twenty-Two Reasons Why a Good Tap Can Go Wrong.* It treats possible troubles in the tapping machine, holder, hole, lubrication, type of tap, speed, or chamfer.

Production Notes 49

Notes on quenching, martempering, salt bathing, and heat treating are among war-production data presented in booklet from E. F. Houghton & Co., Philadelphia.

Instrument Line 50

Bulletin Z6200 from Wheelco Instruments Co., Chicago, presents in condensed form specifications of the company's temperature control instruments, portable potentiometers, radiation heads, thermocouples, and remote controllers.

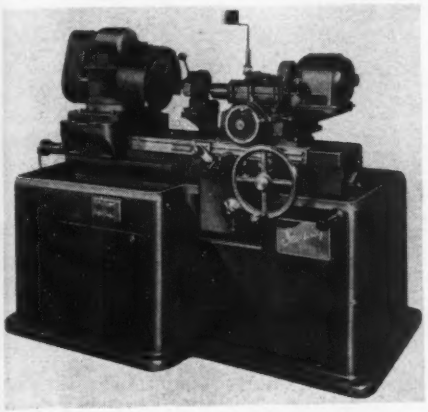
Forging Furnaces 51

Mahr Mfg. Co., Minneapolis, has printed 16-page bulletin of illustrations and specifications on its various types of forging furnaces.

Latest Machine Tools

Internal Grinder..... 52

Hand-table operation, designed to give worker better control when setting up work, and hydraulic operation for high table speeds for long holes are combined in new internal grinder produced by **Sav-way Industries**, Detroit. Each type of operation is independent of other; however, both can be combined on same job in same setting. Table speeds range up to 55 f.p.m.; maximum



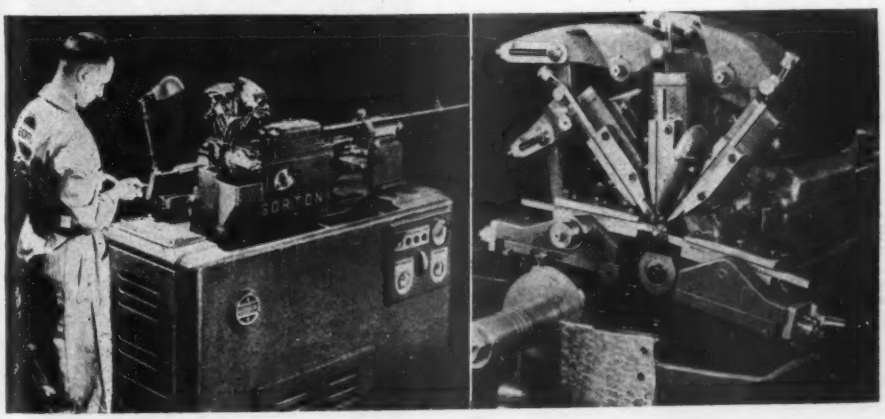
stroke is 24 in., minimum $\frac{3}{8}$ in. Machine base measurements are $70\frac{1}{4}$x$48\frac{1}{2}$ in.; floor space required, 105x$48\frac{1}{2}$ in.; and approximate weight, 5,300 lb.—AVIATION, *July*, '43.

Improved Screw Unit 53

Under exclusive U. S. manufacturing rights from S. A. Joseph Petermann of Switzerland, **George Gorton Machine Co.**, Racine, Wis., is producing automatic screw machine known as Model 16-A, a modernized, improved version of Petermann's P-7. Single-point tool bits and easily accessible cams and controls are reported to provide for precision production of pinions, shafts, screws, and other small parts from .005 in. to 7/16 in. in dia. and lengths from 1/32 in. to $2\frac{3}{4}$ in. Operating method, said to differ from usual way, involves a five-station tool-head; stock is fed to it through a bushing and past cutting tools horizontally stationary (right photo). Thus side thrust of tools is at point of work support. Hardened holders will accommodate tools up to 5/16 in. square, and micrometer screws graduated in .0005 in. provide radial and axial tool adjustments. Unit control panel contains oil-proof switches for regulating spindle speed from 1,100 to 10,000 rpm. through Reeves drive. Variety of camshaft speeds are available by means of Graham unit operating independently of spindle control. Camshaft is driven by 1/3-hp. motor and coolant pump by 1/4-hp. motor; 12-gal. coolant reservoir has removable pan, baffles, and strainer. Bar feed is weight-operated with pneumatic feed available at extra charge. Five-digit counter registers production, and red light flashes when more stock is needed. Weight is 3,000 lb.—AVIATION, *July*, '43.

Chucking-Screw Unit..... 54

Designed for parts production from round, square, or hexagon bar stock and for machining drawn steel parts of different shapes, new twelve-spindle, vertical, automatic bar-feed and chucking-screw machine is announced by machine tools division of **C. I. Togstad Co.**, Kokomo, Ind. Requiring less floor space



IT'S WIRY JOE FOR AVIATION WIRE and CABLE

There was a time that Wiry Joe was merely the largest independent manufacturer of replacement wiring for the automotive industry.

Now, Wiry Joe is also known as an important source of supply for every type of electrical wire and cable for aircraft. The complete line includes starter cable, high-tension cable, primary cable, both original and replacement. Wiry Joe also makes power and welding cable.

And just as Wiry Joe automotive cable won a name for quality, so, too, has Wiry Joe aviation cable. Every item in the line is built to meet rigid Army and Navy specifications, and is produced under the Dostam method of manufacture for uniformity, dependability, high efficiency and long life.

Inquiries regarding wire and cable for any type of service will be answered promptly.

Let Addressograph supply the experience

WHEN modern business methods go into action, it's Addressograph that supplies *accuracy*, *speed*, *economy* and *skill* to business paper work procedures.

Simplicity of method and simplicity of operation get results that daily prompt present Addressograph owners to *extend the use of their equipment*. Installations made for *one* use, now handle *many*, such as issue of War Bonds, processing Government Reports, writing Payroll, Production Control and Inventory Records, identifying Parts and preparing Shipping Documents.

Call in your near-by well-informed Addressograph representative for ideas on full employment of the equipment you already own. Or write the home office.

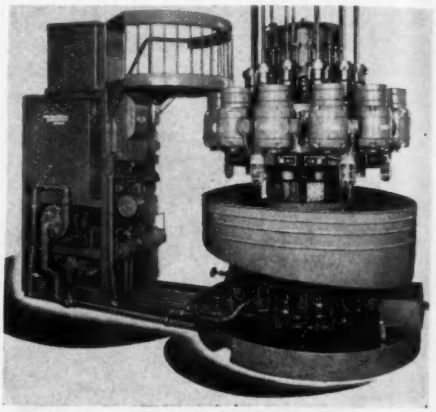
PRODUCING FOR WAR • PLANNING FOR PEACE

Addressograph
DIVISION
ADDRESSOGRAPH-MULTIGRAPH CORPORATION
EUCLID • OHIO

Addressograph is a trade-mark registered in the United States Patent Office

NEW PRODUCTS

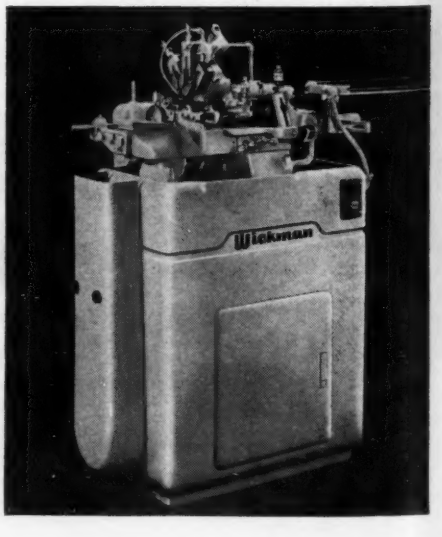
because of its vertical construction (gravity also eliminates need for mechanical feeding) machine can produce a



number of parts simultaneously when tool set-ups are duplicated. The twelve spindles, revolving on Timken bearings, are driven by individual 2-hp. motors mounted on hinge brackets to facilitate adjustment of "V"-drive belts. Hydraulic timing is adjusted by setting split cams on a shaft driven by an adjustable "V"-belt pulley. Tool feed speeds are adjusted by valves. Coolant supply is sufficient to wash chips down into box where they can be collected and removed. —AVIATION, *July*, '43.

Screw Machine..... 55

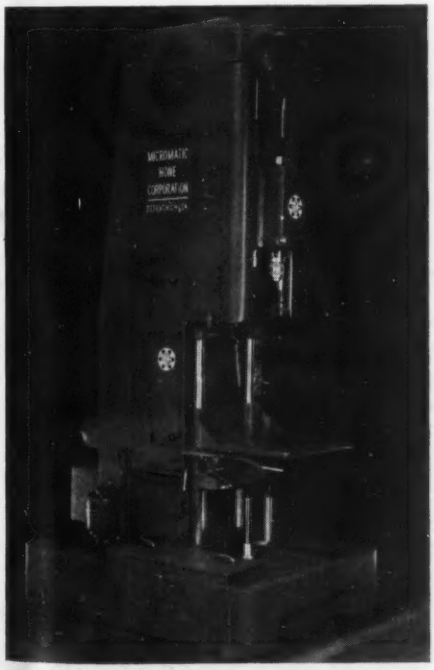
New Swiss-type automatic screw machine introduced by **Wickman Corp.**, Detroit, and designed to use tungsten carbide tools, has 5/32-in. dia. bar capacity and maximum turning length of 1 9/16 in. Spindle speeds range from



1,500 to 12,000 rpm. and machine cycles of 2 sec. to 5 min.; limits of diameter and concentricity are .0002 in. Stock emerges through guide bushing past radially fed tools. Both headstock and hardened steel tools are controlled by cams, and tool slides are lapped to close limits and provided with micrometer adjustments radially and parallel to work axis. Attachments are available for drilling, chamfering, counter-boring, tapping, and threading.—AVIATION, *July*, '43.

Vertical Honers 56

Announced by **Micromatic Hone Corp.**, Detroit, are two new honing machines with capacities of $\frac{1}{4}$ to $\frac{7}{8}$ in. dia. on work up to 12 in. long, and $\frac{7}{8}$ to 2 in. dia. to 12 in. long. Both machines have maximum working stroke of 15 in. Spindle, arranged with integral, mechanically actuated reciprocation of the tool, is driven by a spline turned by a belt. Entire spindle head also reciprocates on flame hardened and precision honed bars under adjustable-speed hydraulic control. Manual adjustment is provided for spindle head. Additional hydraulic controls include automatic



timer for cycle of spindle head movement and dwell control for its stroke. Optional equipment includes three speed-changes for spindle rotation and swinging table.—AVIATION, *July*, '43.

STEELED for the Knock-out Drive

"ALLENS"

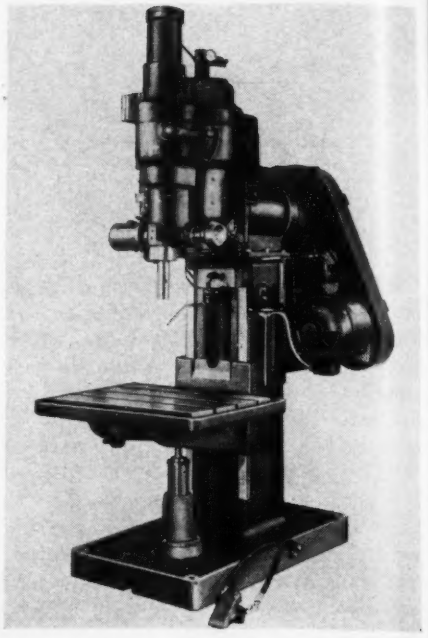
— like our spearhead commanders, pack the qualities of tested steel. In men it's mettle, in screws it's metal but the two are one in beating opposing forces. In machines of war *or* production, the forces opposed to hollow screws are mechanical shocks, violent stresses, vibration. By strength of material, by special processes of forming, by accurate threading, "ALLENS" uphold the invincible Quality that gets our fire-power to enemy capitals — *via the Knock-out Drive!*

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ... CONNECTICUT, U.S.A.

NEW PRODUCTS

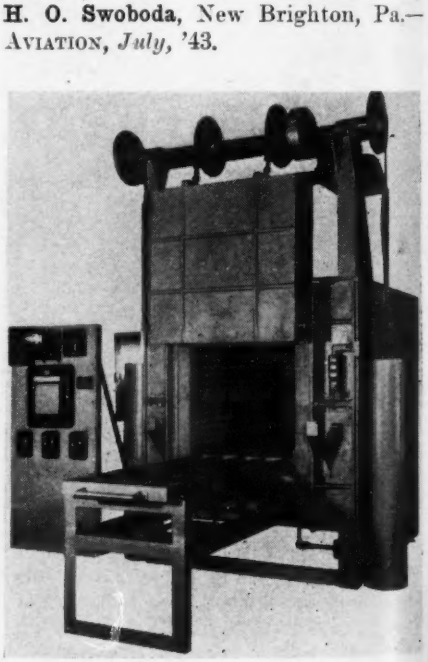
Lead Screw Tapper 57

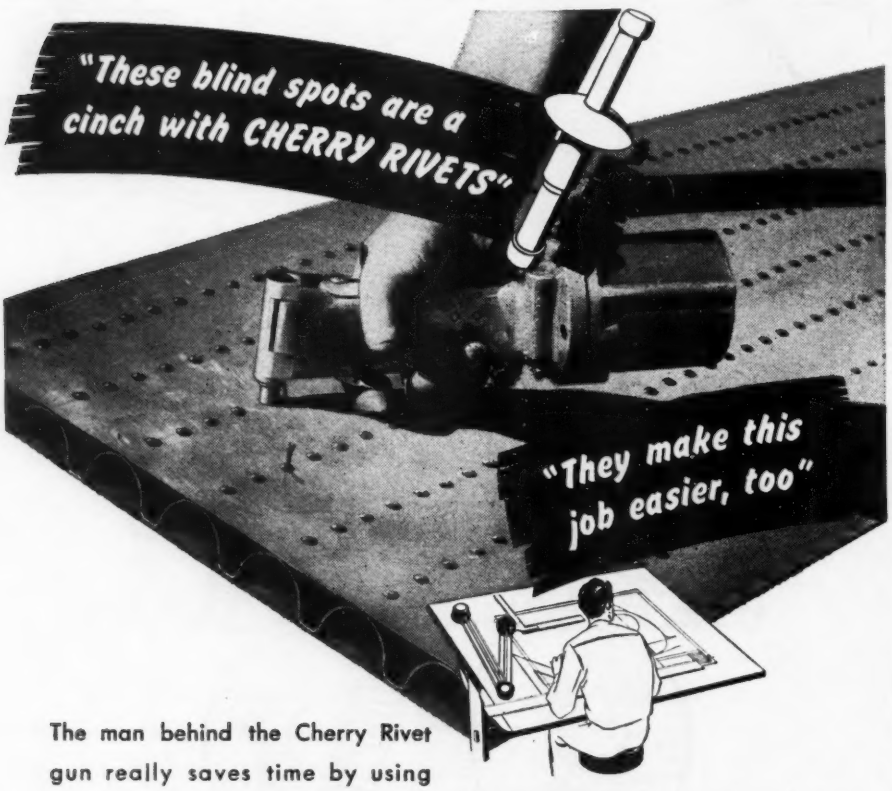
L. J. Kaufman Mfg. Co., Manitowoc, Wis., is producing 1½- and 3-hp. single spindle lead screw tapping machines with ¾-in. and 1½-in. threads in alloy steel. Lead screw and nut operate in continuous oil bath, and clutches are engaged and controlled by air cylinder. Tongue control prevents tap overload. Lead screw and spindle are protected against jamming (in work which may have been placed in fixture upside down) by arrangement allowing spindle to descend only when tap can enter hole in work. Special models are available with multiple heads and index tables for automatic production.—AVIATION, *July*, '43.



Heat-Treating Furnace..... 58

Capable of continuous operating temperatures up to 2,000 deg. F., new heat treating furnace has box chamber 30 in. square by 4½ ft. deep. Charging and discharging loading platform is movable. Motor-operated door mechanism, push-button controlled, automatically shuts off heat when door is opened. Pyrometer heat control can supply varying inputs, and time clock can be set for starting at any predetermined hour. Excess temperature safety device shuts off heat should control fail. Known as Type BRP-A, furnace is manufactured by **H. O. Swoboda**, New Brighton, Pa.—AVIATION, *July*, '43.





The man behind the Cherry Rivet gun really saves time by using Cherry Rivets wherever it would be difficult to use a bucking bar. And he turns out a better job . . . thanks to the positive mechanical action which is an important feature of the Cherry Rivet.

To the engineer these rivets mean even greater advantages. He can now design up to efficiency rather than down to a manufacturing limitation. The high shear and fatigue values and the excellent shank expansion of Cherry Rivets eliminate the necessity of designing away from blind spots in both primary and secondary structures.

CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U. S. PATENTS ISSUED AND PENDING.

Get the complete story on Cherry Rivets. Sizes, styles of rivets, application techniques and riveting tools are fully described in the Handbook A-43. Request your copy from Dept. A-110, Cherry Rivet Co., Los Angeles, California.

Cherry Rivet Company
LOS ANGELES, CALIFORNIA

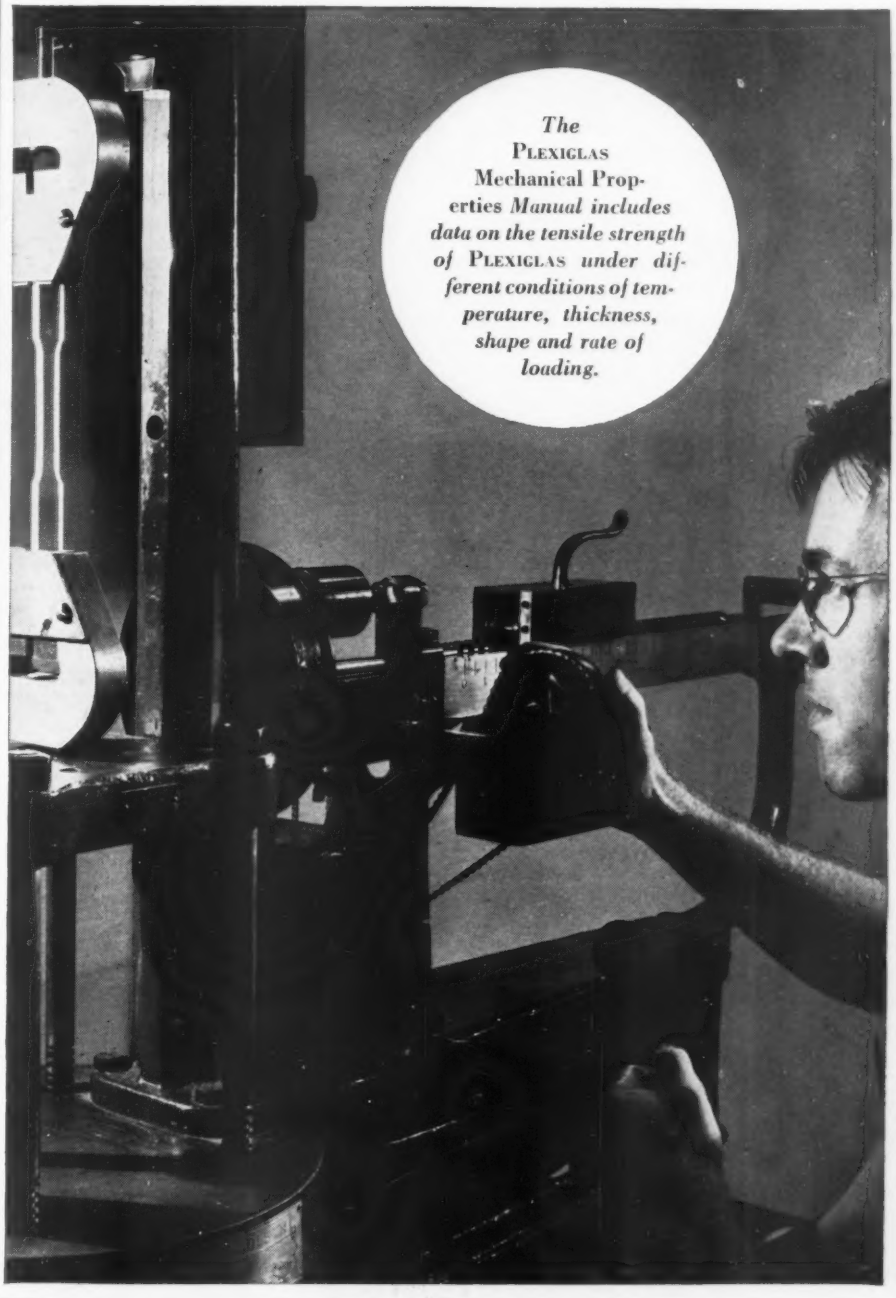
How Strong is
Plexiglas?

THE answer to this and many other engineering questions can be found in the PLEXIGLAS *Mechanical Properties* booklet. This new Rohm & Haas publication gives the results of scores of tests on PLEXIGLAS conducted recently in our new physics laboratory. Illustrated with numerous graphs and new photographs, PLEXIGLAS *Mechanical Properties* is probably the most comprehensive technical handbook ever published on any plastic.

Write to our Philadelphia office for your copy of this important book.

★ ★ ★

Rohm & Haas Company, Washington Square, Philadelphia, Pa. *Other offices in:* South Gate, Los Angeles—Detroit—Chicago. *Canadian Distributor*—Hobbs-Glass Ltd., Montreal, Canada.


The PLEXIGLAS Mechanical Properties *Manual includes data on the tensile strength of* PLEXIGLAS *under different conditions of temperature, thickness, shape and rate of loading.*

THE CRYSTAL-CLEAR ACRYLIC PLASTICS

PLEXIGLAS

SHEETS AND RODS

★

CRYSTALITE

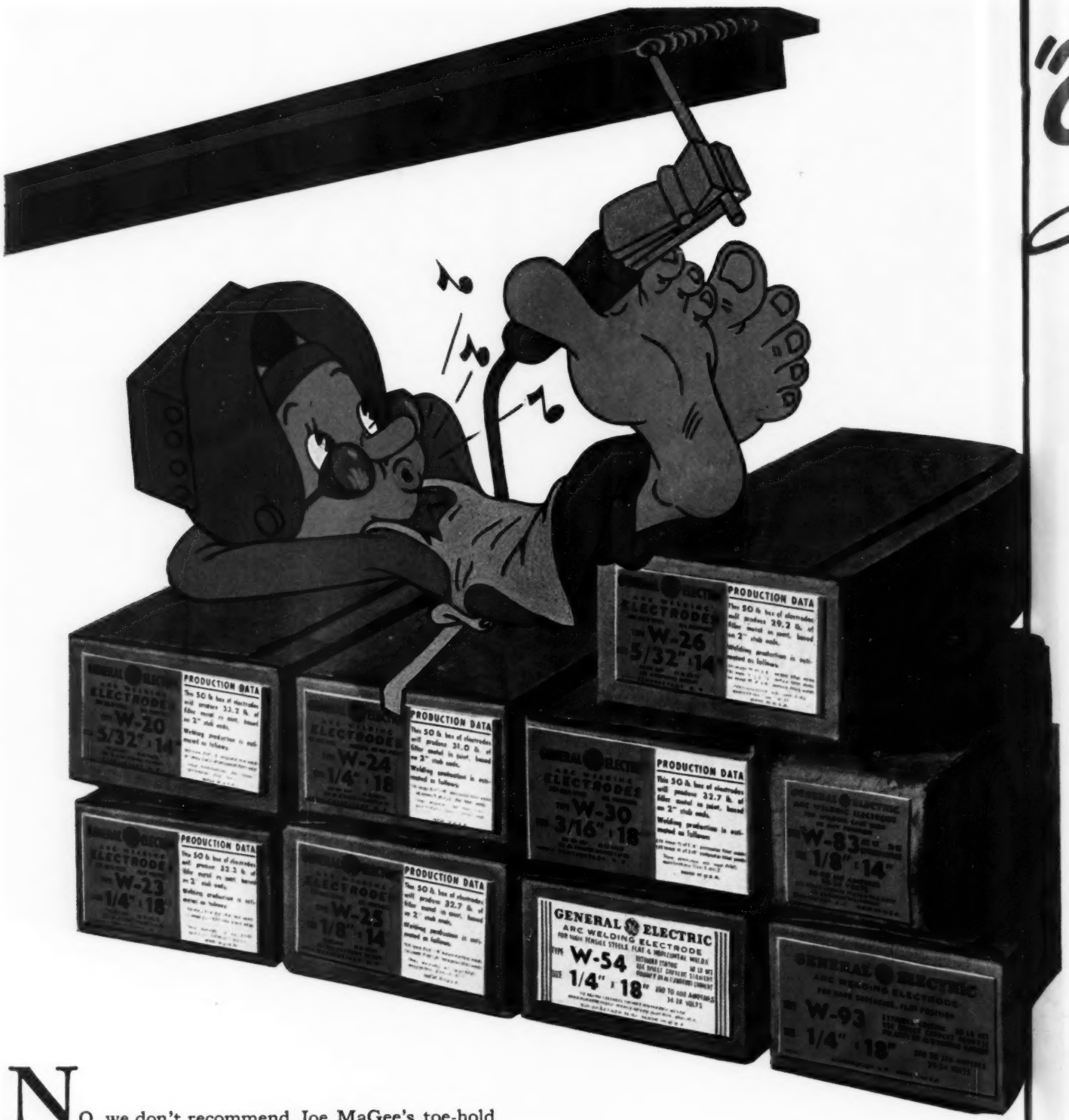
MOLDING POWDER

PLEXIGLAS *and* CRYSTALITE *are the trade-marks, Reg. U. S. Pat. Off., for the acrylic resin thermoplastics manufactured by the Rohm & Haas Company.*

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymes . . . Chemicals for the Leather, Textile and other Industries



NO, we don't recommend Joe MaGee's toe-hold welding grip—it's not very practical—but he sure is right in what he says! These nine G-E electrodes make it possible to use alternating-current for ***95 per cent of all arc welding jobs.*** That means easier welding, more uniform deposition, and up to 36 per cent ***faster*** welding than is possible with direct-current.

Each electrode in this line gives excellent results with a-c, and each is backed by an impressive service record. The W-26 is particularly outstanding. Developed especially for first-class a-c welding in the vertical and overhead positions, this electrode complies with all the following specifications: A.W.S. Filler Metal Specification E-6011; Navy Bureau of Ships, Specification 46E3, Grade 111, Class 1; American Bureau of Shipping, Specification H1G and B1G; A.S.M.E. Boiler Code, Paragraph U68.

Thousands of users have found that these electrodes and G-E alternating current welders are the perfect combination for the fast welding speeds and high quality welds needed to meet wartime production schedules. If you are not already using a-c welding it will pay you to investigate its many advantages. Simply contact your G-E arc welding distributor, or write to General Electric, Schenectady, N. Y.

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"Shucks! with all these good A-C ELECTRODES every welding job is easy!"

95 PER CENT of all Arc Welding Work Can Be Done Most Effectively with G-E A-C WELDERS and These NINE Heavily Coated G-E ELECTRODES

APPLICATION	G-E ELECTRODE	FILLER METAL CLASS (A.W.S.)
Mild steel in any position	W-26	E-6011
	W-20 W-30	E-6012
	W-25	E-6013
Mild steel in the flat position, and horizontal fillets	W-24	E-6020
	W-23	E-6030
High-tensile steel in the flat position, and horizontal fillets	W-54	E-7020
Cast-iron repair	W-83	.....
Wear-resisting surfaces	W-93	.....

ARC WELDING

GENERAL ELECTRIC

672-ST-6748

WHY IS

Tego Resin Film

THE STANDARD AIRCRAFT PLYWOOD ADHESIVE?

THE introduction of TEGO Resin Film in 1935 changed entirely the concepts of aircraft designers and engineers concerning the qualities and uses of plywood in airplanes.

A phenol formaldehyde resin adhesive supplied in sheet form, TEGO made possible plywood having such improved service characteristics that TEGO-BONDED plywood became overnight an important structural material. In addition to giving unexcelled durability, TEGO Resin Film made plywood boil-proof, water-proof, weather-proof and fungus-proof. TEGO also revolutionized the manufacture of plywood—made possible the development of mass production methods.

That is why today TEGO Resin Film is the accepted standard in the manufacture of plywood not only for airplanes and airplane subassemblies but for PT boats, landing barges, Army truck bodies and prefabricated houses.

When interleaved with veneers of fine woods, then hot pressed, TEGO *Resin Film forms panels which meet rigid Army and Navy Specifications for aeronautical plywood.*

The Complete Line of Resin Adhesives

TEGO RESIN FILM, for hot-pressed plywood, produces the most durable plywood known, fully meet the requirements of Army-Navy Aeronautical Specification AN-NN-P-511-B.

AMBERLITE PR-14 is widely employed for rubber bag molded plywood filling the need for a powdered phenolic resin adhesive which possesses extreme water resistance and durability.

UFORMITE CB-551, a pioneer cold-setting urea formaldehyde resin complies in all respects with Army-Navy Aeronautical Specification AN-G-8, has proved an ideal bonding agent in assembling plywood aircraft sections.

UFORMITE 430 AND UFORMITE 500, for either hot-pressed or cold-setting plywood, give remarkably strong bond at relatively low cost.

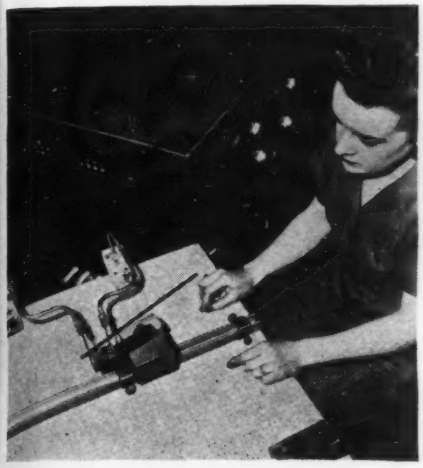
THE RESINOUS PRODUCTS & CHEMICAL COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Shop Equipment & Accessories

Carbide Tool Brazing 59

For practically automatic brazing of carbide tools with electronic induction, equipment is now available to manufacturers, according to announcement of **Carboloy Co.**, Detroit, as the result of research with General Electric engineers. Main item is a 500,000-cycle electron tube oscillator available with 5- or 15-kw. output; water-cooled coils are connected



to the oscillator, After current control and time dials are adjusted, rest of process is automatic. Operator in photo has set the tool tip within coil while brazing material is liquid.—AVIATION, *July*, '43.

Brake Tester 60

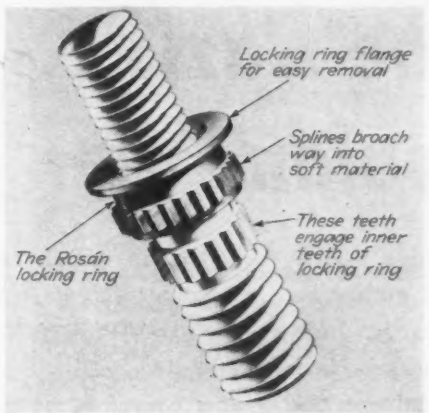
Eliminating taxiing tests, brake tester devised by **Safety Equipment Co.**, South Bend, duplicates actual braking conditions. Airplane wheels are cradled between rollers imbedded in ground, then rollers are turned, brakes applied, and force (simulating that between tire and ground in landing) is measured on dials.

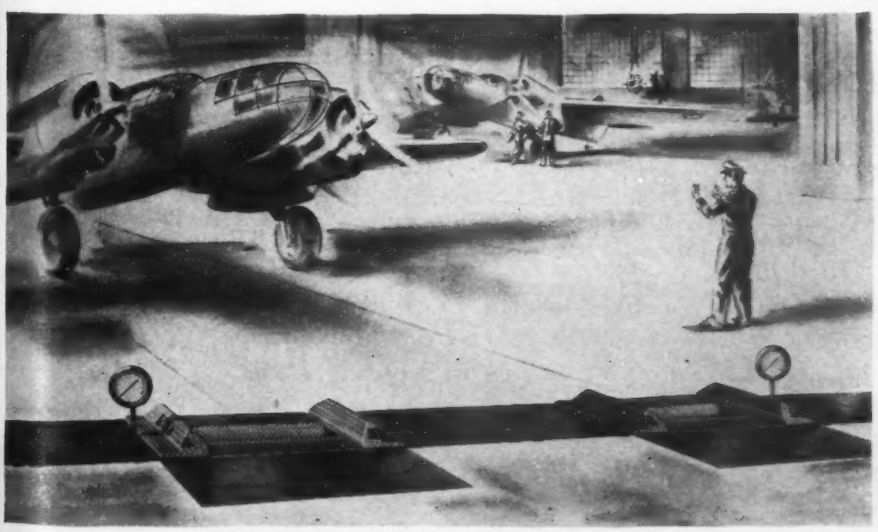
• Announcements of new machine tools, shop equipment, and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and wherever possible, glossy-print photos should be enclosed for illustration. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City.

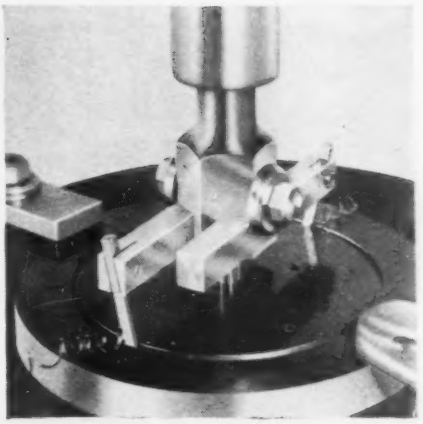
Adjustable to any width landing gear, tester is available in sizes with 36-in. rolls and 22,000-lb. plane weight capacity, also 72-in. rolls and 80,000-lb. capacity. Gages fold under when not in use and hinged plates cover pit.—AVIATION. *July*, '43

Terminal Stud 61

To install this terminal stud devised by **Bardwell & McAllister**, Hollywood, Calif., hole is threaded sufficiently deep


Locking ring flange for easy removal
Splines broach way into soft material
These teeth engage inner teeth of locking ring
The Rosán locking ring



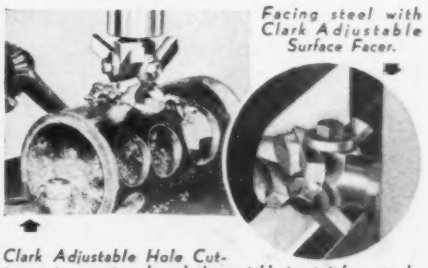


NEW *Adjustable* FLY CUTTER

Holes or Disks 4" to 10"
One Inch Thickness Capacity
Unique Blade Arrangement
Simplified, Long Life Design

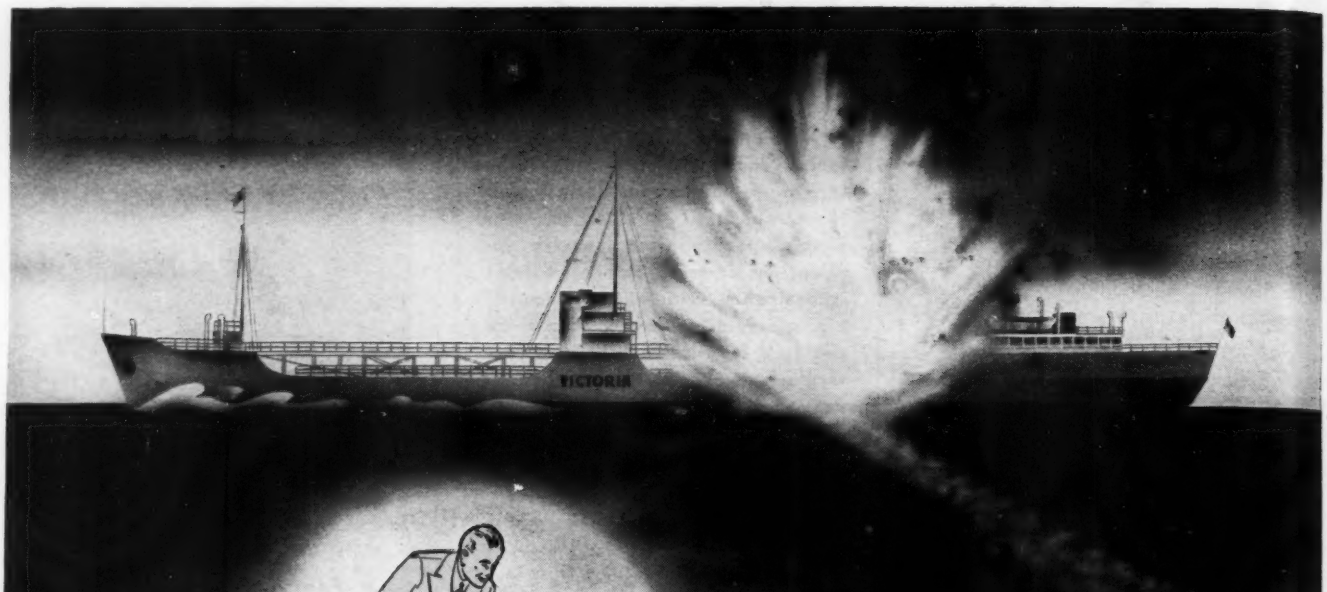
This remarkable new Clark Cutter does the work of several tools, results in substantial operating economies. PITCHED BLADES of precision-ground High Speed Steel set with 11-degree drag cut true and smooth . . . relieve chatter; make clean, long-curl chips, give longer bit life. REMOVABLE PILOTS, hardened and ground, permit use of lead drills. Only ⅛ inch work clearance required; allows deeper cuts without undue blade stress. Straight or tapered shanks. PROMPT DELIVERY on suitable priority.

Write for Bulletin No. 000



Clark Adjustable Hole Cutters cut accurate, clean holes quickly in stainless steel, pipe, plastics, etc. Only seven sizes cover all fractional diameters ⅝" to 3" and up to 1" thickness!

Robert H. Clark Co.
3424 SUNSET BOULEVARD • LOS ANGELES, CALIF.
Manufacturers: Precision Tools, Precision Parts



then I said to myself—

So . . . the Nazis couldn't sink her!

This 12,500-ton, all-welded tanker "Victoria" was torpedoed amidships. Her deck plates buckled but her bulkheads held. Then, the baffled Nazis smashed a second torpedo into her and left, confident she was finished. But those welds refused to yield—even to Nazi TNT. She made it to port and was repaired—ready for the subs again. Some ship, I say!

Some construction, you mean! This is just one of many welded ships that have refused to be licked by torpedoes. Just like our welded M-4 tanks which withstood the Nazi 88's in North Africa. Ships, tanks, planes and guns—they're all welded for strength as well as for savings in time and materials.

Better products and *lower costs*—just what I want in my business after the war. Then why shouldn't I weld my peace-time products?

You should! You MUST if you plan to survive in the face of war-developed ideas. And believe me, your ship of business will sink or float, depending on how well you can stand up against competition on WELDING ECONOMY. Why not start NOW to learn from Lincoln the latest kinks in welding thrift.

THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO

for stud to be screwed into material and locked with Rosan ring. When ring is driven into place, its inner teeth engage serrated stud collar as outer teeth broach their way into material. Pressure of material makes ring close in on serrated collar, forming a solid unit. —AVIATION, *July*, '43.

Automatic Recorder..... 62

Michigan Tool Co., Detroit, has produced recording machine for making automatic paper records of usual dial indicator readings of variations in gear or worm contours, pin diameters, and helical lead of gears. Machine is connected electrically to gear checker so that vari-

ations of .002 in. can be indicated by pen on paper moved either by separate synchronous motor or coupled in synchronism with moving table or spindle of measuring device.—AVIATION, *July*, '43.

Diamond Chipbreaker 63

Felker Mfg. Co., Torrance, Calif., announces development of new diamond-abrasive chipbreaker in which resinoid rim containing diamonds is bonded to laminated linen rather than metal core. Laminations are interlaid with resinous compound and baked into single, rigid form. Made in 3, 4, and 6 in. dia. with $\frac{1}{8}$-in. rim thickness, chipbreakers are termed suitable for cutting grooves, shaping, and form grinding of carbide tips.—AVIATION, *July*, '43.

Titeflex

unimold

with

Auburn

CERAMIC SPARK PLUG CONNECTORS

Titeflex Unimold Detachable Leads represent a new development in the perfection of aircraft ignition systems. Instantly detachable for ease of maintenance in the field, the Titeflex Unimold Leads possess high dielectric strength and resistance to corona.

The Titeflex Metal Hose Co. has accepted Auburn Ceramic Connectors for equipment on Unimold Leads because they, too, have high dielectric strength, do not carbon-track and do not absorb moisture.

AUBURN

Write us for information regarding Auburn Ceramic Connectors

AIRCRAFT DIVISION
AUBURN SPARK PLUG COMPANY, Inc.
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AUBURN SPARK PLUG COMPANY, Inc.
MAIN OFFICE and FACTORY, AUBURN, N. Y.

SMALL METAL TUBING is Our Only Business and We Know It . . .

(MAXIMUM O.D. 5/8" IN MANY METALS)

SUPERIOR

THE BIG NAME IN SMALL TUBING

Aviation Dept., SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

Superior Tubing is being used in such applications as Airframes, Engine Valve Push Rods, Instruments, Hydraulic Lines, Primer Lines, etc.

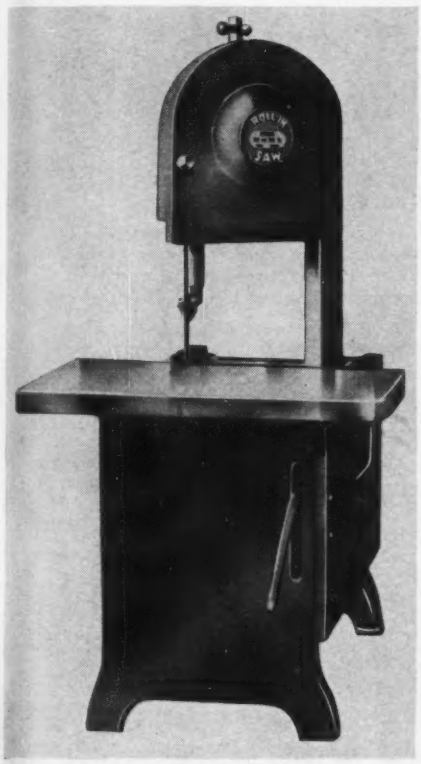
Types are Seamless, Weldrawn and Brawn, meeting aircraft specifications.

Get the facts! Concise data on Superior small tubing is contained in Bulletin No. 48. Write today for your copy to: Aviation Dept., Superior Tube Company, Norristown, Pa.

NEW PRODUCTS

Metal Band Saw..... 64

Universal Vise & Tool Co., Parma, Mich., announces "roll-in" metal cutting band saw incorporating gravity feed in which blade penetrates work through movement of balanced blade wheel on an inclined track. Blade pressure is



automatically regulated by texture and degree of hardness of work, and swivel holding block can be removed for contouring or long, straight cutting. Blades, 8½ to 9 ft., come in three widths, ¼, ½, and ¾ in., and can be run at 81, 161, and 264 ft. per min.; maximum cuts are 7 in. vertically and horizontally. Machine height is 5 ft. 2 in., depth 3 ft. 4 in., width 30 in. Work table is 18½ x 30 in., and 30 in. from floor. Power: ½-hp., 110-v. a.c. motor delivers 725 rpm. Weight is 700 lb.—AVIATION, *July*, '43.

Coolant Spout 65

Flexible metal tube coolant spout made by **J. N. Fauver Co.**, Detroit, is designed to be adjustable to any angle around cutting operation by fingertip pressure. It is available with interior diameters of ⅛ to ¼ in. and in any length.—AVIATION, *July*, '43.

RE-LIGHTING
the new manpower / production *requirement*

HERE'S ONE ANSWER
to this problem...

This new folder tells the whole story. Send for it!

Because most plants operating today were designed for peacetime, *daylight* working schedules, *their lighting equipment is inadequate for night work!*

The folder illustrated gives one answer to industry's problem of *re-lighting*. Silv-A-King's new fluorescent reflectors of non-critical, metal-saving Silv-A-Tex are durable, efficient, inexpensive, and available for prompt delivery. For complete descriptions and specifications of Silv-A-King "Victory" units, write for a copy of "Catalog 43-V" today!

BRIGHT LIGHT REFLECTOR COMPANY, INC.
304 Morgan Avenue, Brooklyn, N. Y.

SILV-A-KING

SILV-A-KING MAKES *Light* WORK FOR YOU

BIRDSBORO
Birdsboro Turret Press
Two-Stage pressing and accurate No-Jar turret indexing assure faster and more exact forming of sheet metal airplane parts. Available in sizes up to 3000 tons.*
BIRDSBORO
Birdsboro Shuttle Table Press
Four conveniently arranged shuttle tables provide access to the press from all sides. Tables individually controlled but fully synchronized with press on automatic cycle, with high speed, no jar traversing and indexing. Available in sizes from 750 tons up to 5000 tons capacity.*
*Patents applied for
Birdsboro Steel Foundry & Machine Company, Birdsboro, Pennsylvania

They're Winning their Wings on the Production Line!

Turning out airplane parts faster and more accurately is the job of these two types of multi-purpose Birdsboro Hydraulic Presses. And they do it superbly well—24 hours a day in key war plants—at rates as high as a half million parts per month!

Notice the exceptional loading facilities that provide access to the presses from *all* sides. This feature, coupled with automatically controlled, fully synchronized loading, pressing and unloading operations, assures *uninterrupted* production.

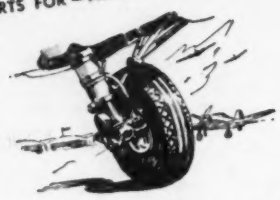
These Birdsboro Presses were engineered with two purposes in mind. First, to provide facilities for immediate war needs. Second, to have the flexibility to handle the wide variety of work that will be their job when Victory is achieved.

If *yours* is a press problem, of the present or future, it will pay you to consult Birdsboro. Our engineers will be glad to work with yours, *right down the line*—from planning to designing to completion.

BIRDSBORO

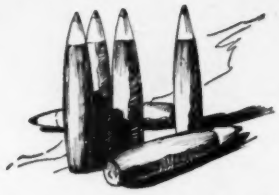
HYDRAULIC PRESSES

PARTS FOR—AIRCRAFT



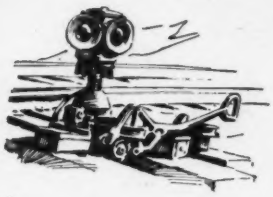
Tail wheel assemblies, actuating cylinders and engine forgings. Brake lining. Camshaft and starter bearings.

PARTS FOR—BATTLE



Shell and shot forgings. Cast bomb parts. Steel armor plate castings. Ammunition hoists. Torpedo parts.

PARTS FOR—TRACKWORK



Crossings, switch stands, switch point locks, guard rails, rail lubricators. Trackwork for industrial equipment.

You Name the Part—

PROBABLY WE MAKE IT

Brake Shoe MAKES PARTS for original equipment and for maintenance; parts that are upset and drop forged; molded fabrics and plastics; ferrous and non-ferrous castings. In war, as in peace, Brake Shoe ships millions of parts to thousands of manufacturers, in many fields of industry.

The services of our research and development engineers are available for immediate or post-war problems.

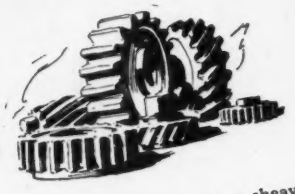
AMERICAN BRAKE SHOE COMPANY, 230 PARK AVENUE, NEW YORK, N. Y.

AMERICAN
Brake Shoe
COMPANY

58 PLANTS SERVING INDUSTRY AND TRANSPORTATION

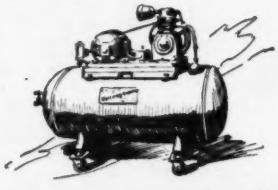
American Brakeblok Division	*Detroit, Mich.*
Ramapo Ajax Division	*New York City*
American Manganese Steel Division	*Chicago Heights, Ill.*
Brake Shoe and Castings Division	*New York City*
Kellogg Division	*Rochester, N. Y.*
American Forge Division	*Chicago, Ill.*
Southern Wheel Division	*New York City*
National Bearing Metals Corp.	*St. Louis, Mo.*

PARTS FOR—MANUFACTURERS



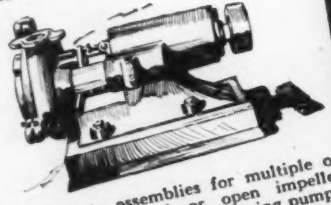
Manganese steel chain, gears, sheaves, sprockets and wheels. Hard surfacing welding rods. Forgings, castings.

PARTS FOR—GARAGES



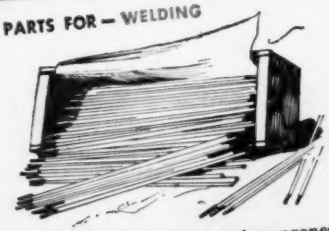
Air compressors. Car washers. Brake lining, fan belts, clutch facing, radiator hose, auto lifts.

INDUSTRIAL PUMPS



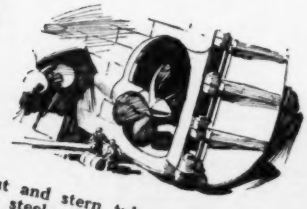
Complete assemblies for multiple or two van closed or open impeller type. Single stage self-priming pumps.

PARTS FOR—WELDING



Welding rods, flux, nickel-manganese filler, applicator bars. Welding products for repair of ferrous equipment.

PARTS FOR—SHIPS



Strut and stern tube bearings. Carbon steel castings for davits and winches. Bronze castings for engines.

Rivet Bucker 66

Announced by **Aero Tool Co.**, Burbank, Calif., is automatic bucker which permits bucking and riveting in one operation by one person. Treadle control actuates

air-cushioned bucker synchronized with standard rivet set. Stressed yoke is $\frac{3}{8}$-in. hot rolled steel, and standard bench model has 15-in. throat. Other sizes are available.—AVIATION, *July*, '43.

Weld Etching..... 67

Increases in the speed of spot welding on aircraft production lines are being credited to use of K-1, a material developed by **Kelite Products**, Los Angeles, to etch aluminum and aluminum alloy surfaces and increase speed and ease of making welds. Tests by Rensselaer Polytechnic Institute indicate that process allows extra safety margin.—AVIATION, *July*, '43.

Push-Pull Filing Tool..... 68

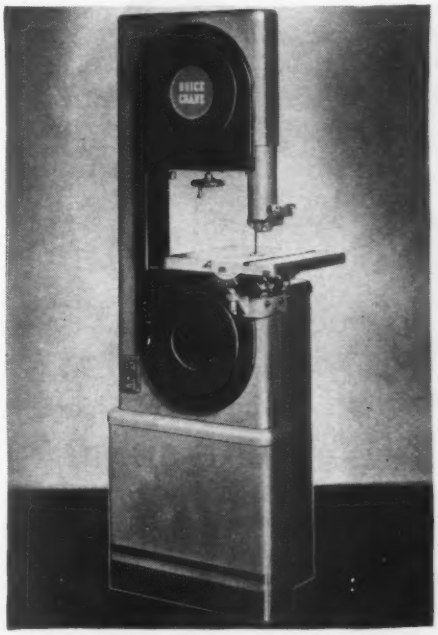
Design improvements, including larger cooling and electrical parts, have been incorporated into new push-pull portable electric tool for filing, burring, chamfering, honing, scraping, sewing, etc. Man-

NEW PRODUCTS

ufacturer, **H & H Research Co.**, Detroit, is producing models with $\frac{1}{8}$- and $\frac{3}{8}$-in. stroke. Both have rate of 1,000 to 1,200 reciprocations per min. with 30- to 40-lb. power developed at working end. They weigh 5 lb.—AVIATION, *July*, '43.

Band Saw.....69

Bench and floor models of contour and cut-off band saw offered by **Boice-Crane Co.**, Toledo, can handle wood or plastic stock up to $8\frac{5}{8}$ in. thick through throat sufficient for pieces of 27 in. dia. Blade tension, said to be unusually low, is indicated on scale. Hinged wheel guard must be closed before machine will run. Adjusted by knob, blade guides will handle sizes from $\frac{1}{8}$ to $\frac{3}{4}$ in. Table, 15x



$15\frac{1}{2}$ in. is supported on trunnions and tilts 45 deg. to right and 10 deg. to left. Degree of tilt is indicated on scale.—AVIATION, *July*, '43.

Skin Fastener..... 70

Applied with thumb pressure on lever, skin fastener marketed by **Clever Tool Co.**, Los Angeles, exerts 35-lb. pull at point of contact. Pressure on thumb trigger releases devise, which has been specially designed not to exceed women's strength. Stock sizes are $\frac{3}{32}$ in. (No. 40 drill) in bright finish and $\frac{1}{8}$ in. (30 drill) in black.—AVIATION, *July*, '43.

The Young Men Know Their Engines

AMERICAN built planes are carrying on along the Mediterranean and in the South Pacific.

Skillful American Pilots, serviced by skilled ground crews, are steadily shoving the Nazi and the Jap back to defeat.

These young Americans are living up to the tradition that made this country prosperous and great.

Fenn precision built parts go into the construction of many planes, ships, tanks — wherever the demand is for special machinery and parts made to accurate measurements.

Fenn acts as prime contractor or sub-contractor on special machinery, parts and equipment. We welcome inquiries from those who need assistance in either developmental work or actual production.

FENN

THE FENN MFG. CO.

HARTFORD, CONN.

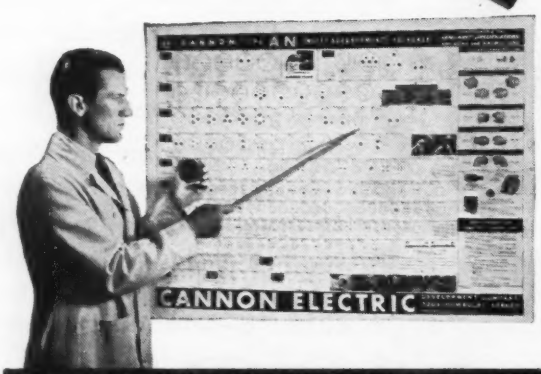
ESTABLISHED 1900

CANNON *Visual Aids*

TO HELP YOU LICK THE MANPOWER SHORTAGE
BY MAKING YOUR WORKERS MORE EFFICIENT

TRAINING FILMS—Ready now! The new Cannon Electric Slide Film with sound tells your employees how to use electrical connectors correctly and efficiently. Clears up confusing terminology. Explains assembly techniques. Shows how AN part numbers are established and facilitates the ordering of replacements.

CATALOGS—Engineers, production executives, service men need the basic information clearly presented in the new catalogs covering many types of Cannon Connectors.



WALL CHART
Gives the insert arrangement and shell sizes on AN specification connectors at a glance, thereby facilitating designing, wiring and servicing operation in factories as well as in the field.

TEAR OUT THIS COUPON AND ATTACH TO YOUR BUSINESS LETTERHEAD

CANNON ELECTRIC

Cannon Electric Development Company, Department A-110
3209 Humboldt Street, Los Angeles, California

Please send us more information on the visual aids checked below:

TRAINING FILM ☐ CATALOGS ☐ WALL CHART ☐

NEW PRODUCTS

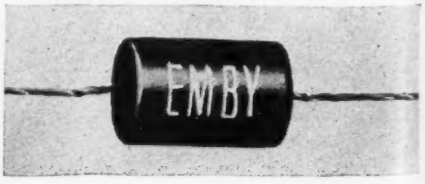
Dunking Basket..... 71

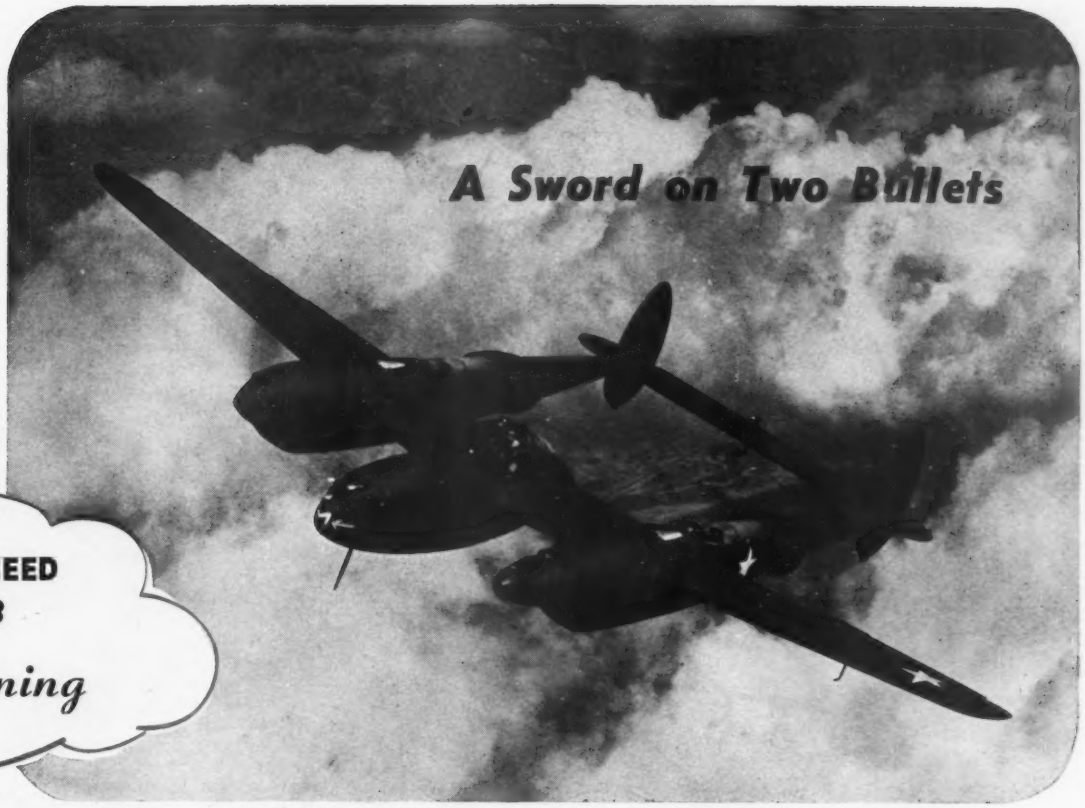
Being supplied with standard 5-gal. pails of carbon met, substitute for carbon tetrachloride manufactured by **Curran Corp.**, Malden, Mass., is new

dunking and drying basket made of scrap metal. Parts to be cleaned are placed in basket, immersed and, on withdrawal, clips on side of basket snap onto side of container allowing surplus cleaning fluid to drain back into can. —AVIATION, *July*, '43.

Selenium Rectifier..... 72

Half-wave type rectifier has been added to line of instrument and relay selenium rectifiers produced by **Selenium Corp. of America**, Los Angeles. Working temperature range extends from — 70 deg. C. to 75 deg. C. with negative temperature coefficient. This unit consists of two rectifying elements of ½ in. dia. in a tubular plastic case measuring ¾ in. rated at 10 v. a.c. Forward impedance is of order of 1,000 ohms; reverse of order 1 megohm per plate. Units are hermetically sealed.—AVIATION, *July*, '43.





LEA METHOD AND MATERIALS

for BURRING, POLISHING and BUFFING

have a hand in the production of this fast fighter

• Aptly termed "a sword on two bullets", the Lockheed P-38 is doing a swell job for us on all the battlefronts. She's fast, hard-hitting, high-flying, well-protected, versatile. She's a ship the Air Force can be—and is—proud of!

To get a ship like the P-38 off the assembly line is a real job calling for the best in engineering and manufacturing skill. With thousands of parts being prepared and assembled, precision and close tolerances are controlling factors. Countless burring, polishing and buffing operations have to be carefully planned and carried out.

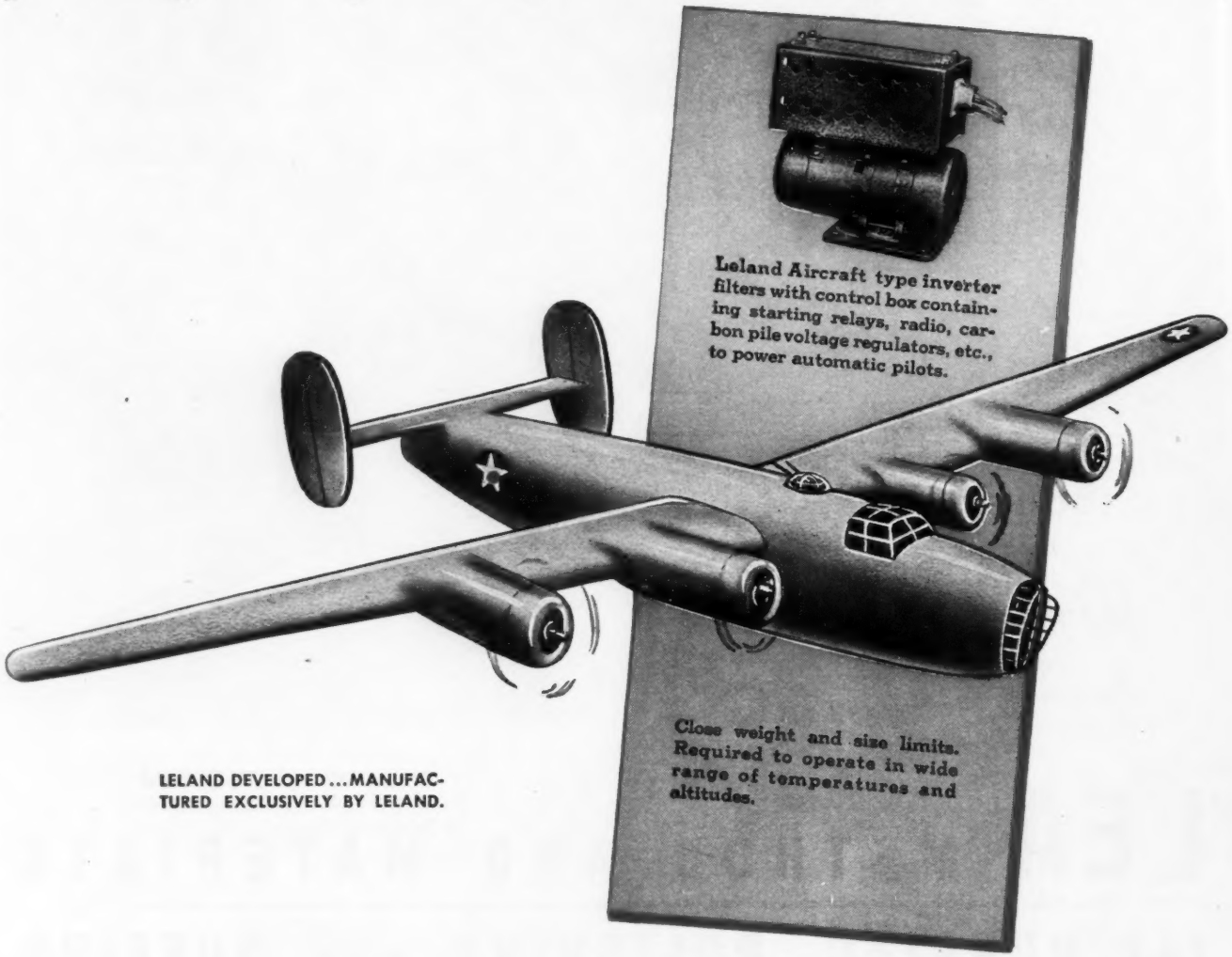
That LEA Method and LEA Materials were selected for many of these operations is, we like to feel, a recognition of our knowledge of and experience with such problems. We are serving many, many war industries in a similar capacity.

THE LEA MANUFACTURING COMPANY

Waterbury, Conn.

Burring, Buffing and Polishing . . . Specialists in the Development of Production Methods and Compositions

7-LM-2



Leland Aircraft type inverter filters with control box containing starting relays, radio, carbon pile voltage regulators, etc., to power automatic pilots.

Close weight and size limits. Required to operate in wide range of temperatures and altitudes.

LELAND DEVELOPED...MANUFACTURED EXCLUSIVELY BY LELAND.

THOUSANDS OF LELANDS FLY DAILY

Thousands of Army and Navy planes go winging through the skies daily and in the nose of thousands of these planes a Leland inverter provides the power for the automatic pilot. Then, as these giant birds settle to earth, Leland D. C. motors lower the landing gears to set them down. Leland aviation equipment has truly earned its "wings."

Leland motors, generators and alternators, inverters and dynamotors have also found their niche in aviation—are serving in laboratory and factory and on power equipped fields the world over.

State your requirements. Leland already has a design to meet your requirements or can develop something to your specifications.

Leland
WAR DUTY MOTORS

THE LELAND ELECTRIC COMPANY ★ DAYTON, OHIO

Riveting time:	Stitching time:	Time SAVED:
495 HOURS	**67** HOURS	**428** HOURS

THE first five jobs changed over to the metal stitching process took but 67 hours at the Curtiss-Wright plant — against 495 hours formerly required for riveting—thus representing the *amazing savings of 428 man hours* per week credited to just one Morrison Aircraft Metal Stitcher!

With additional conversion to stitching, even further time-saving is predicted, not only at Curtiss-Wright—but in plants anywhere working with Aluminum, Stainless Steel, Plastics, Cork, Rubber, Asbestos, Wood or Canvas.

Morrison Metal Stitchers are easy to operate, simple to maintain and thrifty with vital metal—a 5 pound coil of wire makes approximately 10,000 stitches. For further details—and performance records—write today for Bulletin No. 7-A.

MORRISON STITCHERS

PRODUCTS OF THE SEYBOLD DIVISION
HARRIS-SEYBOLD-POTTER COMPANY
DAYTON, OHIO

A Veteran of

59,000 000 *Operations!*

This Clare Type K d.c. Midget Relay is still in good mechanical and electrical condition after 59,448,200 operations—a typical example of the long life and rugged serviceability of a "custom-built" relay. It has been used for pulsing antenna switching relays. It was set for 16 operations per second, energizing a secondary relay having a 90 ohm coil operating on 28 volts.

The Clare Type K d.c. Midget Relay is dwarf-size and feather-weight, measuring only 1½" x 1¼" x 13/16" overall, and weighing approximately 1⅜ ounces. It is "custom-built" for mobile applications, where resistance to constant vibration and severe shock is essential, employing no anti-vibration springs, no bearings to rattle loose.

Spring insulators are made of XXX Bakelite; also available in ⅛" Mycalex, insuring minimum high frequency losses. Screws anchoring spring pile-ups to heelpiece are enclosed in Polystyrene tubes, Glyptol-sealed at head and foot. Can be supplied with various other types of insulation. Each Type K d.c. Midget Relay is given a 1000 volt a.c. insulation breakdown test.

The armature assembly, heelpiece and coil core are made of magnetic metal, carefully annealed. The small coil is carefully wound to exact turns on precision machines, and can be supplied impregnated with a special varnish. It is covered with a transparent acetate tape. Type number and data regarding resistance is shown on each coil. The coil is equipped with a front spool head having a flat side, which locks entire coil in place against heelpiece. Coil voltage ranges from 1.5 volts to 60 volts, d.c.

Contacts are either of 18 gauge silver, rated one ampere, 50 watts, or of 18 gauge palladium, rated 2 amperes, 100 watts; normally open, normally closed, or double throw. Can be furnished with any number of springs up to and including 12.

All metal parts of this relay are specially plated to withstand a 200 hour salt spray test.

Our engineers will be glad to "custom-build" the relay that meets your requirements. Write us regarding your problem. Ask for the Clare catalog and data book. C. P. Clare & Co., 4719 Sunnyside Ave., Chicago, Ill. Sales engineers in all principal cities. Cable address: "CLARELAY".

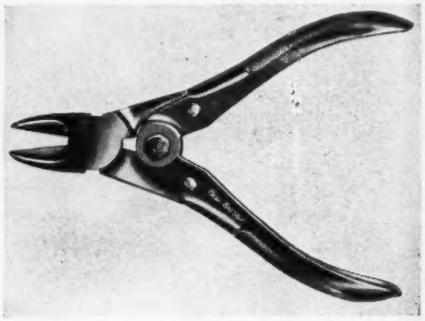
CLARE RELAYS

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

NEW PRODUCTS

Wire Nippers..... 73

Spring action of these nickel plated nippers is reported to produce compound leverage on cutting edge sufficient



to sever piano wire. Maker **New Britain Machine Co.**, New Britain, Conn., announces size as 5½ in. and weight 4½ oz.—AVIATION, *July*, '43.

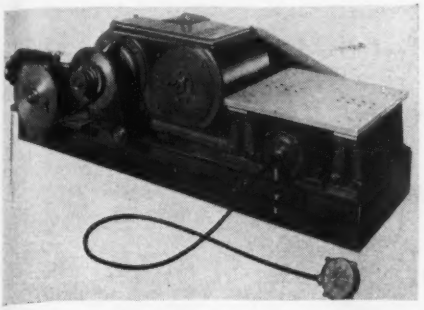
Air Speed Valve..... 74

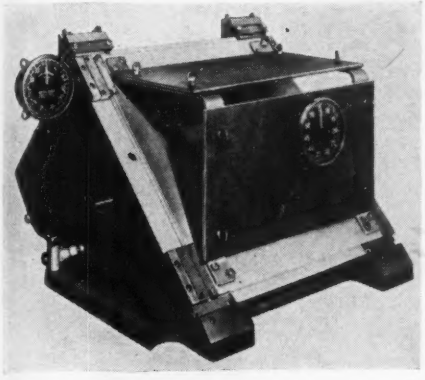
Split-second timing of piston movements through this air speed control valve is reported by maker, **Ross Operating Valve Co.**, Detroit. Wide range of speeds can be obtained through vernier-like adjustment machanism, and specially designed stem and floating

bevel seat puppet maintain positive, steady control at any selected speed. Manufacturer will furnished performance graphs to interested engineers.—AVIATION, *July*, '43.

Vibration Testers..... 75

To produce vibrations of known characteristic for checking parts and materials, **Waugh Laboratoies**, New York City, is producing two testing machines. Model in top photo has 18x18½-in. aluminum table which can be moved horizontally up to 6,000 cycles per min. with 100-lb. load at amplitudes of 0 to .0625 in. Circular motion is produced by model seen in bottom photo, which has table capacity of 10 lb. at 3,000 cycles per min. at maximum amplitude of .031 in. Brackets are provided for vertical or horizontal instrument mounting.—AVIATION, *July*, '43.



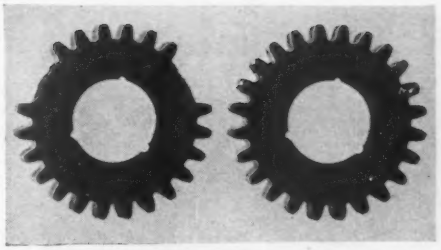


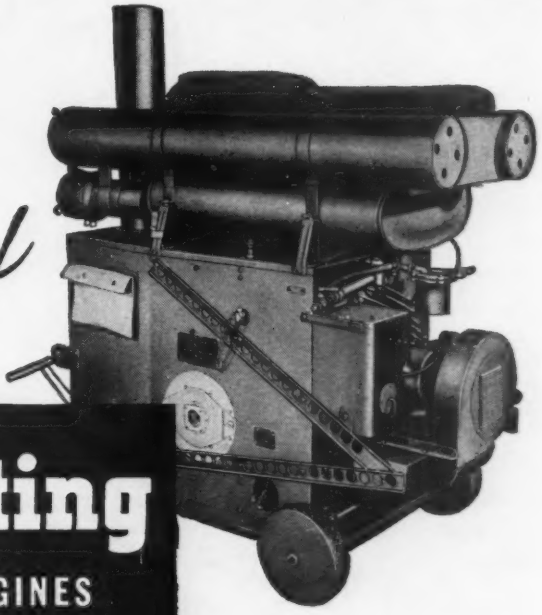
Twin-Thread Screw..... 76

In this screw, two parallel threads starting at opposite sides of the shank and terminating in a single point are said by maker, **Blake & Johnson Co.**, Waterville, Conn., to afford faster, firmer fastenings for wood and plastic assemblies through greater thread area. Less stress is reported to result from cylindrical rather than contoured shank. —AVIATION, *July*, '43.

Parts Salvage..... 77

Right wheel in accompanying photo shows tooth repair done with Castolin Eutectic alloy No. 14 which is stated by **Eutectic Welding Alloys Co.**, New York City, to be completely machinable and suitable for salvage of already machined castings and parts with slight foundry defects and machining errors. "The Castolin Eutectic process," says company, "is a low temperature welding operation by which alloys having a close matching composition with parent metal are applied with a new technique similar to brazing."—AVIATION, *July*, '43.





Designed for

Preheating

AIRCRAFT ENGINES
IN SEVERE COLD WEATHER

Now is the time to consider the cold weather difficulties which aircraft manufacturers, airline and airport operating personnel will encounter next winter!

The Herman Nelson Portable Self-Powered Heaters, originally developed for our armed forces, were successfully used last winter at Army and Navy Bases everywhere.

These portable, light-weight, sturdy, self-powered ground heaters are now available to commercial users who are engaged in essential war activities. Write today for complete information and please include a statement of your particular heating problem.

THE HERMAN NELSON CORPORATION
Manufacturers of Quality Heating, Ventilating and Air Conditioning Products
MOLINE, ILLINOIS

Can you imagine what a beating tank crews would take if there were no protective crash pads to "upholster" that steel interior! BUR-TEX is ideal for the job—because, in addition to its many other features, BUR-TEX has exceptional cushioning qualities.

BUR-TEX felt fabrics are used extensively for vibration dampening, sound deadening, insulating and cushioning purposes in planes, ships, trucks, tanks, jeeps and other wartime applications. Outstanding features of the BUR-TEX "200" Line are high resistance to surface abrasion, moisture, and temperature changes—great tensile strength — pliability — and long life What's more, all BUR-TEX fabrics are economical, easily applied—are available in standard rolls or cut to desired forms.

Learn how BUR-TEX can solve your wartime material problems —and fit into your planning for peacetime production in the years to come. Write for colorful, illustrated brochure—"The Interesting Story of BUR-TEX."

BURLINGTON MILLS
INCORPORATED
BURLINGTON · WISCONSIN

NEW PRODUCTS

Rivet Holder 78

To eliminate waste of dropped rivets, **Cleveland Pneumatic Tool Co.**, Cleveland, has developed Riv-N-Jector, a

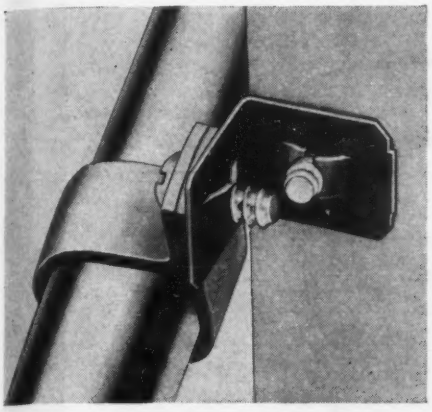
lead pencil-like tool holding up to 50 rivets. Operator inserts rivet into hole with device, which thereupon produces another rivet for next insertion.—AVIATION, *July*, '43.

Aircraft Relays 79

Holding connections at stresses up to 10½ G, new class S relays of **Automatic Electric Co.**, Chicago, have twin contacts to insure current flow should one of them be blocked by dirt or grit. Contacts will make or break 1 amp. noninductive or ½ amp. inductive load and carry 2 amp. Coils are available with 150 to 3,500 ohms resistance. Springs may be arranged in any make or break combination.—AVIATION, *July*, '43.

Conduit Fastener 80

Use of standard bonding clamps is reported in rigging aircraft pipes and conduit with this bracket made by **Tinnerman Products**, Cleveland. Adjustment



of angle of pipe can be made by applying screw driver to speed nuts which are part of the assembly.—AVIATION, *July*, '43.

Relief Valve..... 81

Self-stabilizing relief valve developed by **Merit Engineering**, Providence, R. I., is based on principle of hydraulic balance and requires one light spring for range of pressure control from 0 to 3,000 lb. It is furnished in all standard tubing sizes with internal or external threads or flanged ends.—AVIATION, *July*, '43.

Sawing Lubricant 82

The Doall Co., Des Plaines, Ill., reports that tests involving its metal sawing lubricant, Saw Eez, indicate that it substantially reduces scoring of blades in straight and contour metal cutting.—AVIATION, *July*, '43.

Gage Block Box 83

Illustration shows how new gage block box requires only a fraction of space required by older type. In new box, made by **Savage Tool Co.**, Minneapolis, blocks

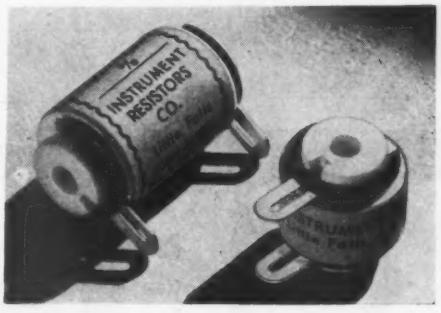
are racked at a slight angle on their ends in marked slots. Material is kiln-dried solid walnut, treated to prevent acidity from affecting block surfaces. Dimensions are 11x4½x2 in.—AVIATION, *July*, '43.

Rectifier..... 84

Direct current voltages of 6, 12, 24, 36, and 48 and series-parallel switch to double amperages at half voltage are delivered by various model stationary and portable Rectodyne rectifiers having capacities up to 4,000 w. Ventilating fan is driven by fractional horsepower motor. Maker, **McColpin-Christie Corp.**, Los Angeles, reports that dry disk element can stand intermittent overloads up to 100 percent. Rectifier's dimensions are 16x16x29 in.—AVIATION, *July*, '43.

Resistors..... 85

Two wire-wound resistors with slotted .025 hot-tinned copper terminals for stranded or solid wire measure 9/16 in.



dia. and 1 in. long. Their respective ratings are reported as ½ w. at 500,000 ohms and 1 w. at 1 megohm. No. 6 holes are provided through centers of bobbins for mounting. Maker is **Instrument Resistors Co.**, Little Falls, N. J.—AVIATION, *July*, '43.

Tape Printer 86

For marking airplane electric wires, **York Electric & Machine Co.**, York, Pa., has devised scotch tape printer for strips to be attached to circuits. Code number, which can be varied in printer as required, is printed on under, or sticky, side of tape, which is then backed up with another opaque tape sealing marking against moisture.—AVIATION, *July*, '43.

ANOTHER GILBARCO CONTRIBUTION

Built especially for aviation fueling service, the Gilbarco Filter-Funnel has been approved and used for ten years by the U. S. Navy, as well as by commercial air lines, private fliers, and the air forces of our Allies.

The Gilbarco Filter-Funnel is designed to promote added safety in flight by eliminating such causes of motor failure as sand, lint and water in gasoline. It represents one more Gilbarco contribution to the technique of fueling and servicing modern aircraft.

Gilbarco

ARMY E NAVY

GILBERT & BARKER MFG. CO.
WEST SPRINGFIELD, MASS.

TESTOR CHEMICAL CO. TESTORS ROCKFORD, ILL., U.S.A.

CONTROL LABORATORY DATA SHEET

CAMOUFLAGE ENAMEL, QUICK DRYING
PRODUCT

14109A Army Air Force
SPECIFICATION NO.

412
BATCH NO.

APPEARANCE: Smooth, homogeneous, dries to dull finish - Color, Olive Drab #41.

TOXICITY: No toxic substances present.

NON-VOLATILE: 61%

VISCOSITY: .85 poise at 25°C. when 4 volumes enamel are thinned with 1 volume Naphtha (AN-VV-N-96).

WORKING PROPERTIES: Excellent leveling. Wet hiding power: 1700 sq. ft. per gal. (Pfund Cryptometer).

DRYING TIME: To touch in 6 minutes; hard in 47 minutes.

LIFTING PROPERTIES: Non-lifting at 1, 4, 8, 16, 32 and 96 hours.

ADHESION: Adheres well to aluminum, steel, zinc chromate primed surfaces, and sealer-surfacer combinations.

RESISTANCE TO FLUIDS: Retains satisfactory film characteristics after immersion in water, hydrocarbons and hydraulic fluid.

FLEXIBILITY: Withstands 180° bend around 1/8" rod after baking at 212°F. for 4 days.

INFRA-RED REFLECTANCE: Complies with requirement, having a reflectance lower than Aircraft Gray and higher than Olive Drab Porcelain Standards.

REMARKS: This camouflage finish is an excellent final coating over zinc chromate primer or sealer-surfacer combinations. Its extreme durability, water impermeability and close adhesion are a measure of desirable protective qualities. Visual and infra-red light falling on the enamel film result in excellent camouflage effects to the naked eye and the aerial camera.

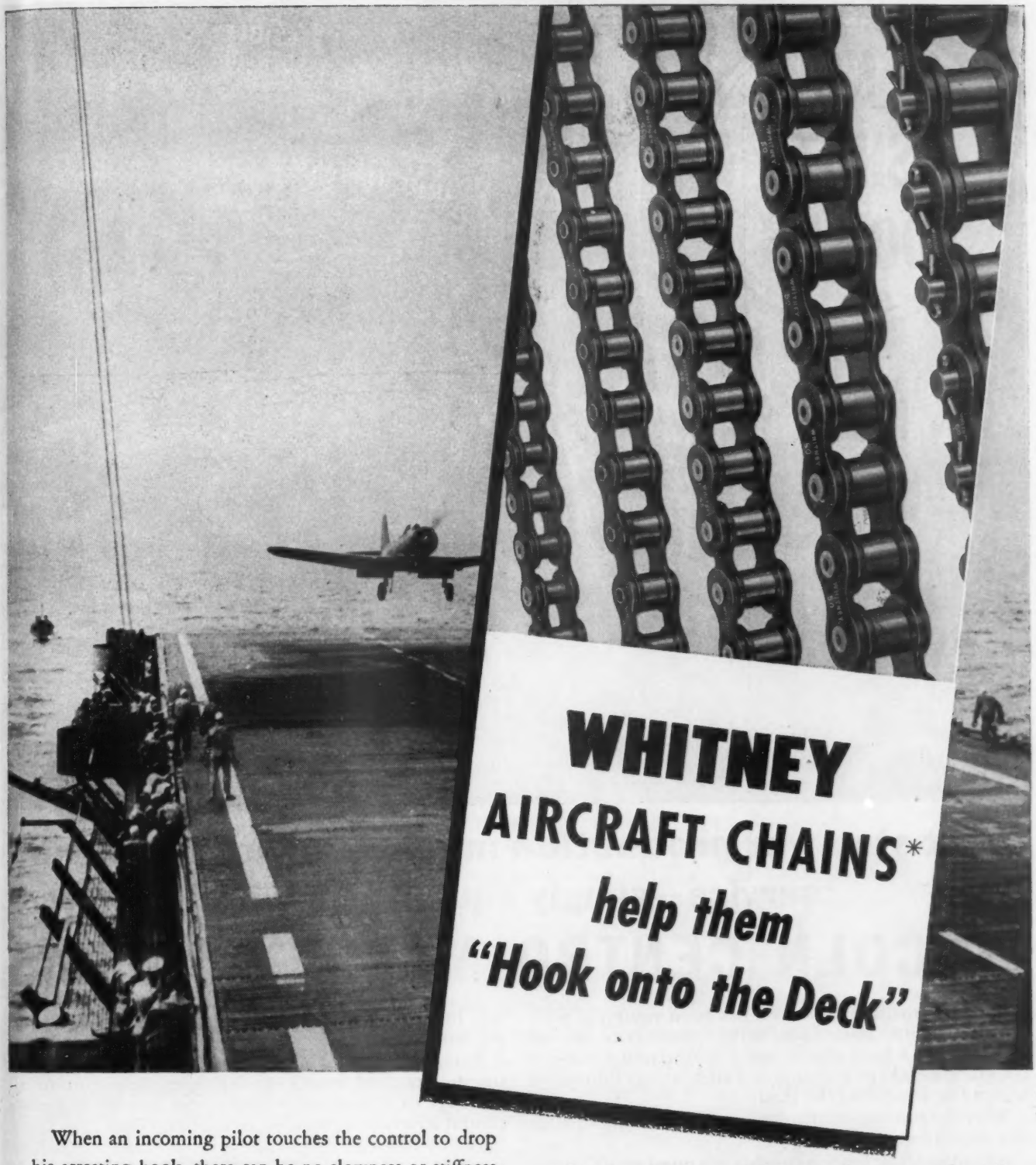
No. 3 in a series of Laboratory Data Sheets on Specification Finishes. Save and file these pages . . . or send for standard-size report forms punched to fit your binder.

TESTORS

AIRCRAFT FINISHES

● Write today for our new and complete file folder of U. S. Army, Navy, and Air Force Specification Finishes . . . and remember that our laboratory is at your service in the development of new and improved formulations to meet specific finishing problems. Send for folder describing our modern production facilities.

TESTOR CHEMICAL CO., ROCKFORD, ILLINOIS, U.S.A.



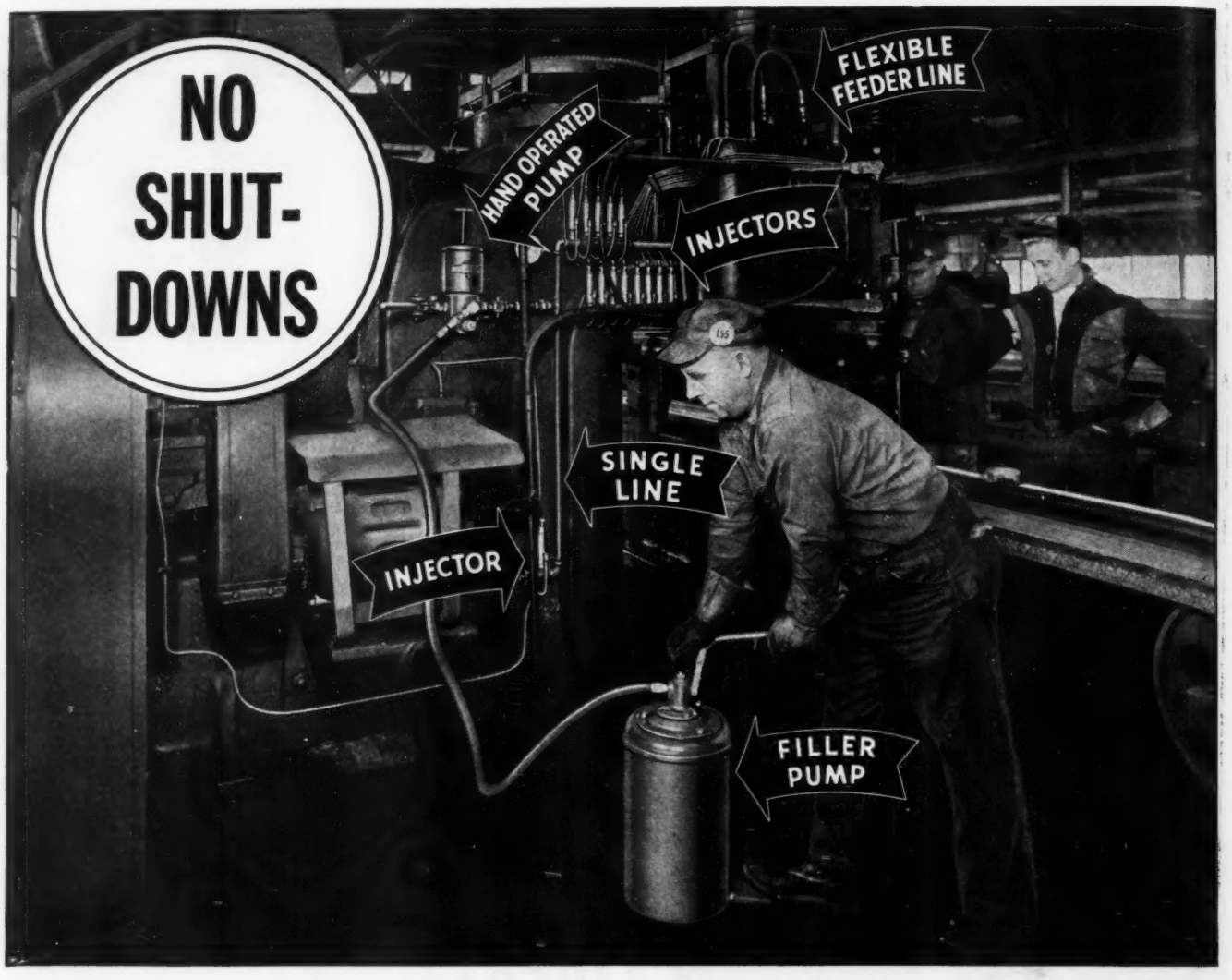
WHITNEY AIRCRAFT CHAINS* help them "Hook onto the Deck"

When an incoming pilot touches the control to drop his arresting hook, there can be no slowness or stiffness of response. So on many carrier-based planes, the prompt and positive action of arresting-hook mechanisms is underwritten by the specification of Whitney Aircraft Chains.

This is one of dozens of plane mechanisms and controls for which Whitney Roller Chains and Sprockets have been chosen for their dependability . . . plus their extreme compactness, flexibility, lightness in weight. And today, these Whitney precision products are made available *directly* to the aircraft industry through the personalized, specialized service of the Whitney Aviation Division. This service places all of Whitney's technical and manufacturing resources at your command . . . to engineer Whitney Aircraft Chains into your particular design in the shortest possible time. A Whitney engineer is at your call . . . *when do you want to see him?*

***PRODUCT OF AVIATION DIVISION of THE WHITNEY CHAIN & MFG. CO.**

HARTFORD, CONNECTICUT



Don't stop war production machines for lubrication service--simply equip them with

LINCOLN CENTRO-MATIC SYSTEMS

The duplicator, shown above, has been equipped with a Lincoln Centro-Matic Lubricating System. Now instead of requiring a long shut-down for lubricating service, the machine is kept running and all bearings lubricated with a few strokes of the pump.

Why not provide your war production machines with this modern equipment.

A Centro-Matic System consists of a number of Centro-Matic Injectors — one for each bearing — and a hand operated or a power operated Centro-Matic Lubricant Pump. A power operated system can be semi-automatic or it can be full automatic. The injectors can be grouped in manifold or located separately at each bearing. In either arrangement only a single lubricant supply line is required.

This modern Lincoln method of lubrication provides a simple, practical means of delivering lubricant to all bearings of a machine, or group of machines, from a central source—without stopping machines.

The ARMY-NAVY PRODUCTION AWARD for high achievement in the production of war equipment, conferred upon the Lincoln Engineering Company has had a star added. This star symbolizes 6 more months of exacting service to our Armed Forces, delivering vital materials so necessary for ultimate Victory.

Write us today for complete information

143-17

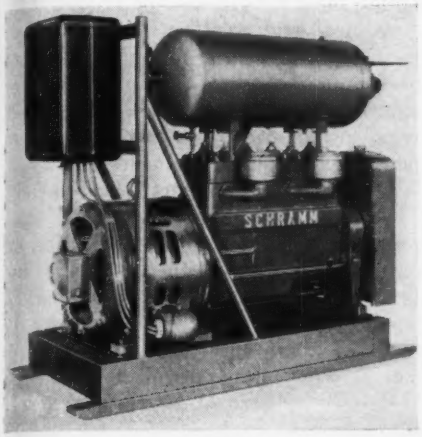
LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MO., U. S. A.

Air Compressor..... 87

Schramm, Inc., West Chester, Pa., lists standard equipment of this direct motor drive air compressor as two air



cleaners, discharge flange, intake and pilot valve unloaders, and water connections for self-contained cooling system. This model, No. 210, has six compressor cylinders with 4½-in. bore and 4½-in. stroke, giving 300 cu. ft. displacement.—AVIATION, *July*, '43.

Terminal Puller..... 88

Armstrong-Bray & Co., Chicago, announces new bearing and battery terminal puller, Steelgrip No. 13 and 13A, in models with 2- and 5-in. reach. Hooks are long and thin enough to reach down into bearing races between bearings and motor housings.—AVIATION, *July*, '43.

Machine Switch..... 89

Suitable for installation for foot or knee control, thus freeing operator's two hands for his work, electric switch produced by **Nathan R. Smith Mfg.** Pasadena, Calif., has phosphor bronze springs

and ¼-in. tungsten points. Case is rubber, and connections can be made with screwdriver. It is rated at 10 amp. at 125 v., 5 amp. at 220 v., and guaranteed for 40,000 operations per year. Size 4½x2⅜ in.—AVIATION, *July*, '43.

Plastic Insulator..... 90

Printloid, Inc., New York City, is offering new high frequency plastic material for insulators under name Plasticeramic, said to combine almost identical electrical characteristics of polystyrene with improved machining properties. Withstanding higher temperatures, Plasticeramic has been approved by the Signal Corps for certain applications within 5 to 10 megacycle range. Dissipation factors range from .00036 to .00088 between 100 kilocycles and 100 megacycles.—AVIATION, *July*, '43.

"YANKEE" TOOLS

GET THINGS DONE!

Speed is their middle name. Like an arrow in flight, they go true to the mark in straight-line production. Spiral Screw Drivers. Automatic Drills. Ratchet Bit Braces. Tap Wrenches. Quick-detachable Vises with swivel bases. These and other "Yankee" Fine Mechanics' Tools get things done . . . with speed and precision.

Speed is inherent in the very *design* of "Yankee" Tools, which for almost a half century have contributed to the efficiency and reputation of American production . . . a priceless asset in a war where *time* is the greatest shortage of all. Be sure to provide priority ratings whenever possible. Order from your supply house or write to us . . . c/o Dept. A-7.

"YANKEE" SPIRALS

SIMPLE • COMPACT • STRONG

A SIZE FOR EVERY PURPOSE

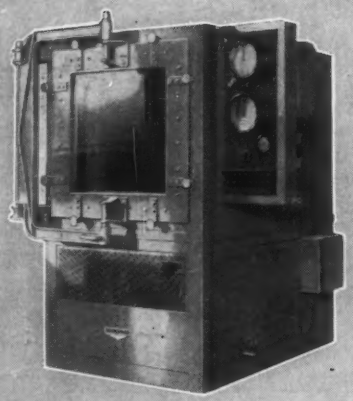
"YANKEE" TOOLS

make good mechanics better

North Bros. Mfg. Co., Phila., Pa., U. S. A.

Established 1880

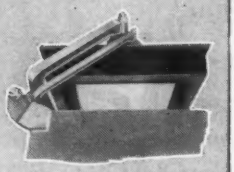
KOLD-HOLD



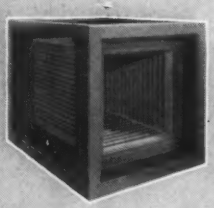
Stratospheres

. . . for testing

Aircraft instruments, radio receivers, transmitters, batteries, wire, metals and various devices are thoroughly tested under predetermined levels of temperature and pressure with KOLD-HOLD Stratospheres. There is no need to wait for "natural" stratosphere conditions . . . produce them at will in your own plant. Available in six variations of model shown, and in larger sized units. Send for complete details and new Catalog No. 431.



Ball-bearing suspension and guide-arm make doors easy to operate and keep in perfect alignment.



Cold-Liner interior of KOLD-HOLD Stratosphere, showing rugged, heavy-duty construction.

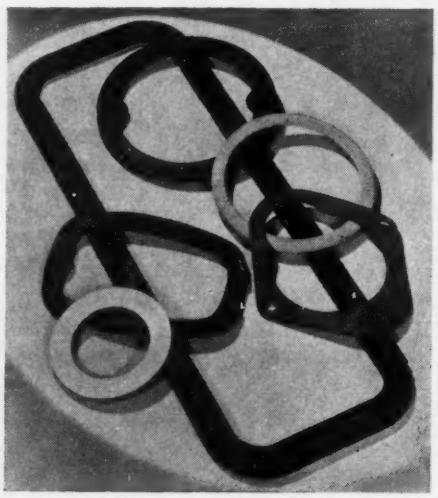
New York — 254 W. 31st St. — PE 6-1161
Chicago — 201 N. Wells — RAN 3986
Los Angeles — 1015 W. 2nd St. — MI 4989
Philadelphia — 2414 Clover Lane — Upper Darby — SHErwood 0622

KOLD-HOLD MANUFACTURING CO.
442 N. Grand Ave., LANSING, MICH., U.S.A.

NEW PRODUCTS

Rubber Alternates 91

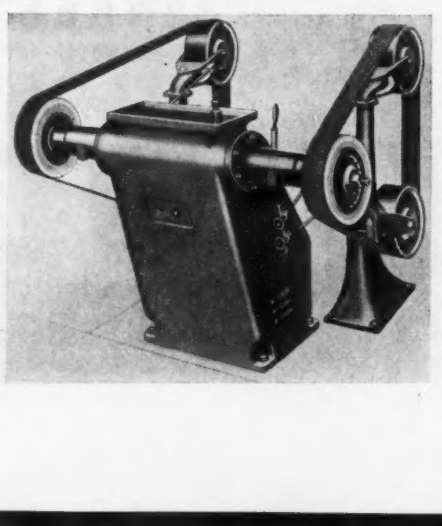
Three new sealing materials developed by **Felt Products Mfg. Co.**, Chicago, as alternates for rubber are: (1) R-196, a reclaim rubber material with high water,



compression, and abrasion resistance qualities, supplied in gasket forms from .020 to .125 in. thick, hardness range from 55 to 80 shore durometer; (2) syntoflex for use where oil, aromatic fuels, gasoline, and other chemicals are present; (3 a synthetic rubber strip as an alternate to sponge rubber, with felt base and made in various shapes and lengths to 6 ft.—AVIATION, *July*, '43.

Belt Backstand 92

Vertical arrangement of pulleys is designed to make this abrasive belt backstand idler suitable for installation in small space. With controls for tightening and aligning, machine can use any size belt up to 6 in. wide at speeds up to 10,000 surface ft. per min. Unit is constructed for easy attachment of dust



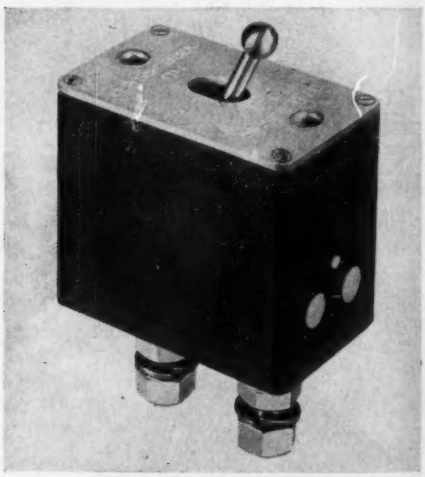
collecting hoods and is made by **Jones Engineering Co.**, Ellwood City, Pa.—AVIATION, *July*, '43.

Plastic Powder 93

A high heat resistant Lucite methyl methacrylate resin molding powder has been announced by **E. I. duPont de Nemours**, Wilmington, Del. Prepared from usual basic materials, the new powder, a company engineer says, "will be available in granular form for compression molding and has all the temperature characteristics of injection or extrusion powder." When molded at injection temperatures of 30 to 50 deg. F. higher than regular Lucite, powder is reported to produce articles capable of withstanding temperatures 30 to 40 deg. F. higher than usual.—AVIATION, *July*, '43.

Circuit Breaker 94

New aircraft circuit breaker manufactured by **Square D Co.**, Detroit, has capacities of 80, 90, 100, and 125 amp. at 30 v., d.c. and is calibrated and sealed at the factory. Breaker mechanism and toggle switch are combined into one unit. Tests of 10-G acceleration and ambient temperatures of −50 to 135 deg. F. are



reported to cause no malfunctioning.—AVIATION, *July*, '43.

Welding Electrode 95

Harnischfeger Corp., Milwaukee, has introduced new all-position electrode for use with a.c. transformer welding machines. Suitable for mild steel, it is shipped in 50-lb. containers in sizes of 1/8, 5/32, 3/16, 1/4, and 5/16 in. in 14 and 18 in. lengths.—AVIATION, *July*, '43.

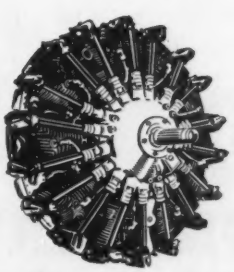
Plastic Tool Making 96

Quick, cheap manufacture of drill jigs, dies, hammer blocks, and mandrels for plywood is announced possible by Specialty Division of **Machine & Tool**

Makin' the Grade... A LYCOMING FEATURE

WHEN YOU FIRST GET IT STRAIGHT WHAT MAKES 'EM FLY!

No. 1 of a series sketched from life by Clayton Knight



LYCOMING MODEL R-680 NINE CYLINDER RADIAL ENGINE USED IN PRIMARY AND ADVANCE TRAINERS BY THE ARMY AND NAVY AIR FORCES.

MAKERS OF AVCO PRODUCTS

A Lycoming engine is apt to be the first power plant that sweeps you up from the earth. What it does through your primary and advance training will affect your whole attitude towards flight. That is why complete dependability has always been part of the name Lycoming.

LYCOMING
AIRCRAFT ENGINES

LYCOMING DIVISION — THE AVIATION CORPORATION, WILLIAMSPORT, PA.

Like a phone in your car?

After the war..

. . . the two-way radiotelephone will be employed by American industry as a convenience, a safeguard and a business requirement. This modern method of communication has many proven applications in the following fields:

Aviation	Railroading
Marine	Public Utilities
Police Patrol	Fire Fighting
Trucking	Engineering

Mining

If you think you may be able to employ two-way radiotelephone communication in your field, we would be pleased to discuss your problem without cost or obligation. We have nothing to sell since our entire output has been placed at the disposal of the United Nations all over the world!

•

Requests for information and literature from responsible parties may be addressed to Jefferson-Travis Radio Manufacturing Corporation, 380 Second Avenue, New York.

THE development and production of two-way radiotelephone equipment for military purposes is convincing evidence that you will employ this unique form of communication in many undreamed-of ways after the war. Long before Pearl Harbor, Jefferson-Travis was making superior two-way radiotelephone equipment for ship-to-shore and plane-to-ground communication. With Victory, it will again be used for these and a great many other peacetime purposes by all nations in Tomorrow's World!

JEFFERSON-TRAVIS

RADIOTELEPHONE EQUIPMENT

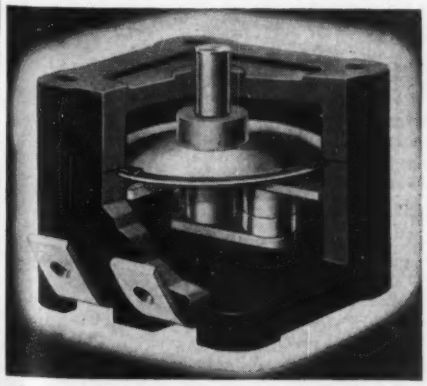
NEW YORK • WASHINGTON • BOSTON

NEW PRODUCTS

Designing Co., Philadelphia, through use of Formrite. This material, a composition of organic and inorganic substances, is pored into mold, where it solidifies at room temperature. It is stated that no allowance has to be made for shrinkage or expansion. Casting, as photo indicates, can be finished by unskilled labor. —AVIATION, *July*, '43.

Sealed Switches 97

Bakelite switch cases sealed to keep out dirt, dust, and oil are announced by **Allied Control Co.**, New York City, to have these characteristics: Contact arrangements single pole, single throw; contact ratings, noninductive, 50 amp. at 12 and 24 v., d.c. and 110 v., a.c.; plunger travel differential .006 to .012



in.; over-travel .050 to .070 in. at max. pressure; vibration 10 G horizontal or vertical; weight 5 oz.; dimensions 1$\frac{11}{16}$x1$\frac{13}{16}$x1$\frac{13}{16}$ in.—AVIATION, *July*, '43.

A splash of gasoline...a spark...and there's a blaze running amok, threatening vital American battleplanes.

But as soon as the alarm sounds, the peril can end...if a duGas fire extinguisher is near at hand to conquer the fire, quickly and decisively.

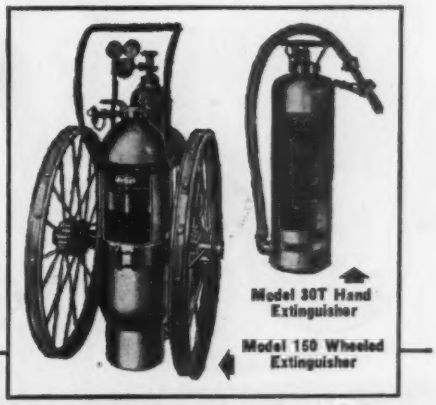
DUGAS GETS RESULTS FAST!

In contact with fires, duGas releases great blankets of gases which have a powerful flame-killing effect. DuGas is *always* ready for use in a split-second . . . it never hardens, freezes or evaporates. Long storage won't cause it to go stale . . . it is unaffected by damp or dry air. Moreover, its use produces no toxic gases. DuGas is harmless to everything except fire!

duGas

The recently revised duGas wall chart showing the characteristics of all types of Approved Hand Fire Extinguishers is available on request.

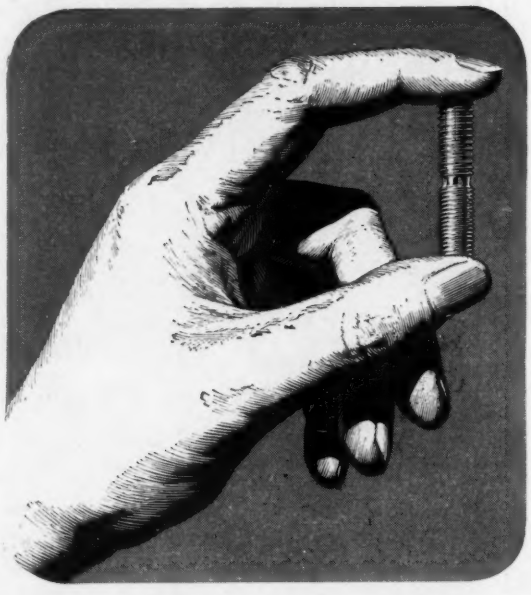
Available in Models 15T and 30T Hand Extinguishers, Models 150 and 350 Wheeled Extinguishers.



Write for details and priority information.

DUGAS ENGINEERING CORPORATION • MARINETTE, WISCONSIN

Owned and Operated by Ansul Chemical Company



They wanted a perfect stud

— turned out by the millions
— accurate to ten-thousandths

THE studs used in one of America's most famous high-efficiency radial engines must be as nearly flawless as man can make them. Millions were needed—and in a hurry.

Manufacturers found the answer in *pretempered* Amercut Cold Finished Steel Bars. Why? Because pretempering, as developed by American Steel & Wire engineers, provides in bar stock the *identical* physical properties that are required in the finished product.

By eliminating heat treatment of parts after fabricating, pretempering makes re-straightening, grinding, cleaning and re-dressing of threads unnecessary. It's a time and cost saver. It minimizes rejections.

Used in radial engine studs and similar parts, pretempered Amercut Bars really pay off. They speed up output, promote dimensional stability and insure the maintenance of high physical standards. They can be used with equally good results on other applications in which similar high requirements must be met.

Listed below are other airplane materials that have found their place in America's finest planes. Tireless check and scrutiny safeguard their quality and insure their fine performance in service. Our mills have the facilities to produce them in large quantities.

THESE AIRPLANE MATERIALS HAVE EARNED THEIR WINGS:

AIRCRAFT QUALITY WIRE
Every type, including stitching wire, hinge-pin wire, strut and tie wire, lock wire, cotter-pin wire, special shape wire. Supplied in carbon, alloy and stainless steels. Bright, tinned or galvanized finishes.

AIRCRAFT CONTROL AND STRUCTURAL CABLES
Assemblies and fittings.

COLD FINISHED BARS
Standard analyses in round, square and hexagon shapes.

COLD ROLLED STRIP STEEL
Stainless, carbon and alloy in widths up to 24 inches.

SPRINGS
Extension, Compression, Torsion, Flat Spiral or Motor types.

WIRE FORMS
Special formations and sizes.

WELDING ROD
Bare—carbon, alloy and stainless.

AIRCRAFT SPECIAL NAILS AND PINS

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

WHEN THAT EXTRA SURGE OF POWER IS NEEDED

DEPEND ON HALL-GROUND VALVES AND VALVE SEATS

Into the experience of every pilot there come times when his own safety, as well as that of crew and passengers, depends upon an extra surge of power.

That's the time he can be thankful for properly seating valves,—for valves and valve seats ground to HALL standards of precision and finish.

HALL grinding equipment is so almost universally adopted for both production and maintenance of all types of aero engines (Axis excepted) that valve failure has been practically eliminated in both commercial and military flying.

For the duration our production facilities are devoted entirely to the winning of the war but our engineers will be glad to discuss your post-war plans with you NOW.

The Hall Manufacturing Co., Toledo, Ohio

HALL

1 Model AW Wet Type HALL ECCENTRIC Aviation Valve Seat Grinder. Made in both production and maintenance types. Other aviation models, portable and stationary, for every seat grinding need. Precision, finish, speed and operating ease and economy characterize all models.

2 Model 80-A wet type HALL Aviation Valve Refacer. Has dual motors, rheostat control of grinding speed, special type collet that will not brinnel valve stems and many other features. Provides precision and finish to match HALL-ground valve seats.

SOLAR HEAT EXCHANGERS IN PRODUCTION

Inquiry and consultation on Heat Exchangers are invited by Solar's Engineering Division. Variety of design — both parallel and cross-flow types—is available. Solar Exchanger units are the logical development of over thirteen years' experience manufacturing "anti-monoxide" Exhaust Systems. Like Solar Manifolds, Solar Heat Exchangers are built for most efficient service on all United Nations' air battlefronts.

ARMY (E) NAVY

SOLAR

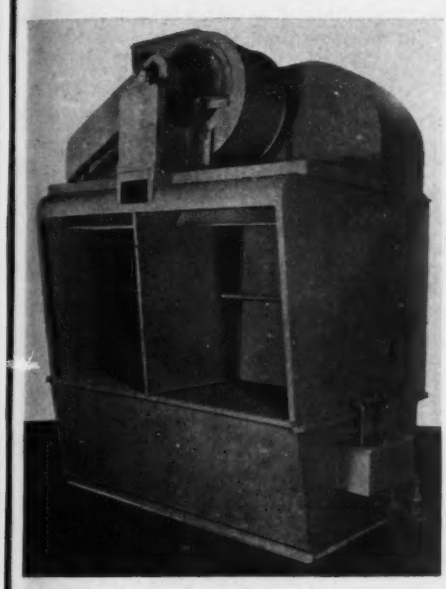
EXHAUST SYSTEMS—

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO, CALIFORNIA

NEW PRODUCTS

Dust Collector..... 98

A fan is only moving part in this magnesium dust collector designed by **Industrial Equipment Corp.**, Detroit.



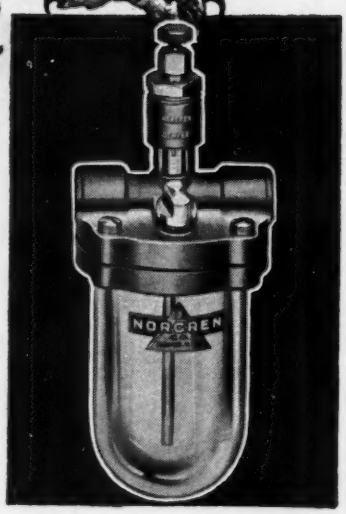
Air is drawn into machine, where it is sprayed with water, causing dust to fall. Cleaned air is returned to re-circulate in room.—AVIATION, *July*, '43.

Relay Control..... 99

A polarized d.c. relay "micropositioner" manufactured by **Barber-Colman Co.**, Rockford, Ill., is designed for remote positioning of control motors and for control of air valves, cowl flaps, trim tabs, etc. Contact tongue is on a balanced armature, and mechanism can be inspected through transparent Lucite case. Specifications: Sensitivity .10 v., .002 amp.; weight 6 oz.; contact rating .5 amp. at 28-v. non-inductive load.—AVIATION, *July*, '43.

5 Mile Dives
Tough on Headphones
Buy BONDS For VICTORY!
Permoflux Dynamic Headphones Meet the Challenge — They Breathe and Outperform at any Level.....
Efficiency in action is their keynote! Designed for instantaneous pressure difference compensation at all altitudes, Permoflux Dynamic Headphones provide extra efficiency and greater safety under every battle condition. Today's Permoflux developments will set the pace for peace time tomorrow. Inquiry is invited on essential sound reproduction problems.
TRADE MARK
PERM-O-FLUX
CORPORATION
4916-22 W. Grand Ave., Chicago, Ill.
PIONEER MANUFACTURERS OF PERMANENT MAGNET DYNAMIC TRANSDUCERS

Striking Power



Striking power, brilliant as the flash of a killing eagle, is built into every air tool by its builders.

You can preserve that power indefinitely only by providing Norgren air-borne Lubrication —continuously! Investigate...

NORGREN *air line* LUBRICATORS

Install directly into air line. They inject exactly enough oil into the air stream to create an oil-air fog, lubricating every working part of the air tool.

Check wear in use. Stop destructive corrosion when idle. Automatic. Sight-feed. Save more than they cost in short order! Size and type for every purpose. Write to C. A. Norgren Co., 220 Santa Fe Drive, Denver, Colorado.

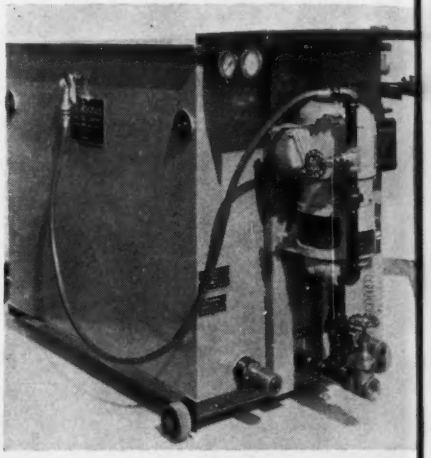
CATALOG 400

Norgren

NEW PRODUCTS

Washing Machine.....10

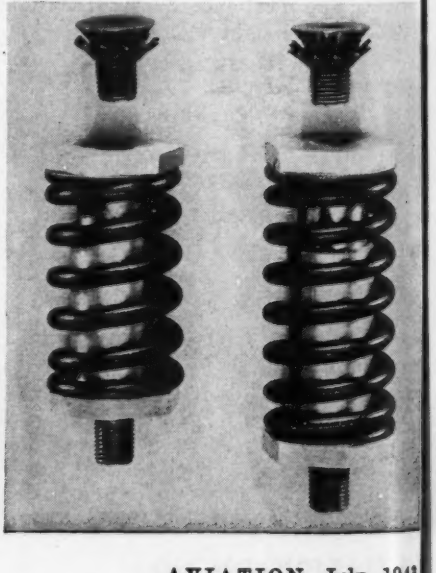
Made by **Magnus Chemical Co.**, Ga wood, N. J., for metal fabricators whos production does not warrant installatio of large, automatic equipment, portabl



washing machine is designed to handl parts in three ways: In baskets if small individually if large, or hung in cleaning solution. Machine can use emulsifiable or chlorinated solvents and has im mersed, thermostatically controlled elec tric units for heating alkaline solu tions. It is available in three sizes 24x18x40 in., 36x24x40 in., and 48x30 40 in.—AVIATION, *July*, '43.

Stripping Units.....101

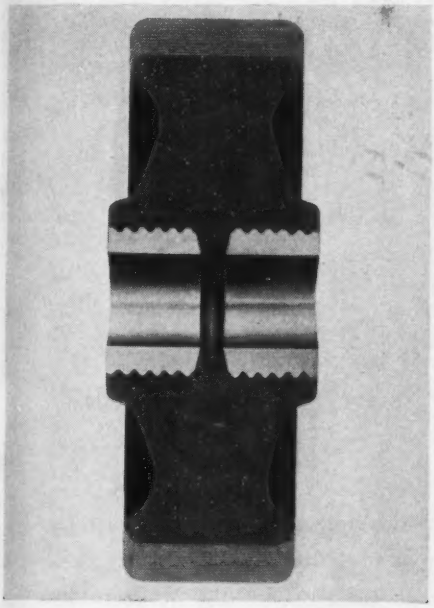
Removal and replacement of stripper plate without taking die out of press o disturbing set-up is reported through use



of improved "Strippits," spring stripping units made by **Wales-Strippit Corp.**, North Tonawanda, N. Y. Units are self-contained, self-aligning, and built-in spring is held compressed by retainer and assembly link. One end of unit has screw thread which holds it to punch or die shoe; the other end has tapped hole for screw which holds the stripper plate in proper position.—AVIATION, *July*, '43.

Metal Wheel Hubs.....102

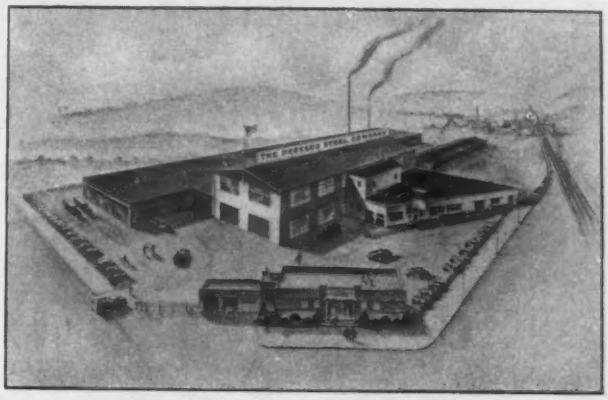
Sectional photo shows how armored metal hubs have been incorporated in laminated plastic-fabric wheels by **Rapids-Standard Co.**, Grand Rapids,



Mich. This development is reported by company to make wheels suitable for service on powered industrial trailers. Sizes available, with or without bearings, are 10 x 3 and 12 x 3½ in.—AVIATION, *July*, '43.

Electrical Brushes.....103

New grades of brushes for ring and commutator applications have been developed by **Keystone Carbon Co.**, St. Marys, Pa., among them types for precision control apparatus. Shunts are molded into brush. Other reported characteristics are low contact drop, high current carrying capacity, and low coefficient of friction.—AVIATION, *July*, '43.



HEAT TREATING EQUIPMENT

Made by
THE PRESSED STEEL COMPANY

Here is heat treating equipment that reduces overhead and speeds up production. This equipment also gives you two other important qualities—it weighs less and lasts longer. Specify lightweight heat treating equipment for lower cost and easier installation. We will be glad to help you solve any unusual or difficult specification problems with speed and accuracy.

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OVER THE MEDITERRANEAN
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The AVIATION NEWS

BLANE STUBBLEFIELD, Washington E. EUGENE MILLER, New York JOHN FOSTER, JR., New York HERB POWELL, New York

Engineering Meeting Hears Papers On Production and Postwar Prospects

Los Angeles (Special to AVIATION)—An interim report on the aviation industry's war production progress, together with both dark and bright predictions on the postwar outlook, were given to a four-day meeting here of the American Society of Mechanical Engineers. Thirty-four papers and three peace previews were presented at 17 aviation section meetings.

From eight brief papers and round-table discussions on "Design for Production," during the first evening session, it appeared that better tooling and designs more adaptable to production efficiency have resulted from close cooperation between design and tooling engineers.

On postwar conditions, Arthur Nutt, engineering vice-president of Wright Aeronautical, predicted that markets for planes would equal those for motor boats (of which there are 300,000). Gordon Brown of Douglas Aircraft envisioned a boom in air transport and urged that products and packages be designed for air shipment. Citing recent developments, J. Parker Van Zandt, CAB consultant, predicted a large expansion of South American air transport.

In an address at a luncheon meeting Gen. E. P. Sorensen, assistant chief, AAF Staff Intelligence, said that German air power failed to conquer England because Nazi leaders did not develop the formidable concept of strategic bombing which the Allies are now employing "to hasten the weakening of enemy resistance and to reduce the ultimate cost of the final assault."

American strategy, he said, is based upon "economy of effort" and involves use of the long range bomber to methodically knock out selected industrial targets. "It is, on a big scale, a vertical envelopment for denial of supplies, munitions, and equipment for the enemy's fighting forces." An analysis of an opponent's production facilities, he said, "results in the discovery that a relatively small percentage of industrial units need be destroyed in order to ruin the ability to wage war in modern times."

As an example of the effectiveness of strategic bombing, Gen. Sorensen revealed that "it has been estimated that the RAF's attack on the Renault plant in Mar., 1942, denied the German army the equivalent of the heavy transport needed for more than two and a half divisions."

Some 34 papers on aviation subjects were presented to other sessions of the meeting. Outlining various adjustments made by Consolidated Vultee as the number of women employees increased to 65 percent of present hirings, W. G. Tuttle, director of industrial relations for the company, said women had proved to be good workers, but he warned employers to remember that women in factories "are entering a situation for which neither their past experience nor training has fitted them."

W. I. Beach, chief plastics engineer of North American Aviation, reported development of plastic substitutes, lighter, cheaper, and more serviceable than original aluminum parts. He described the process as "a method of treating thermosetting laminated material which permits forming of objects having simple and compound curvatures." A paper by Wilbur W. Reaser of Douglas Aircraft, considered the respective advantages of steam, exhaust hot air, and internal combustion airplane heaters. Developments of rubber mountings to reduce engine vibration were described by Paul C. Roche of Lord Mfg. Co.

Other sessions were devoted to production engineering, applied mechanics, power, hydraulics, and management.

Lockheed Will Finance Private Plane Sales

Looking toward the financing of private airplanes when the war is over, Lockheed Aircraft Corp. has acquired the majority interest in Pacific Finance Corporation of California and associates through purchase of a block of 381,205 shares held by Transamerica and associates at a cost of $15.25 a share.

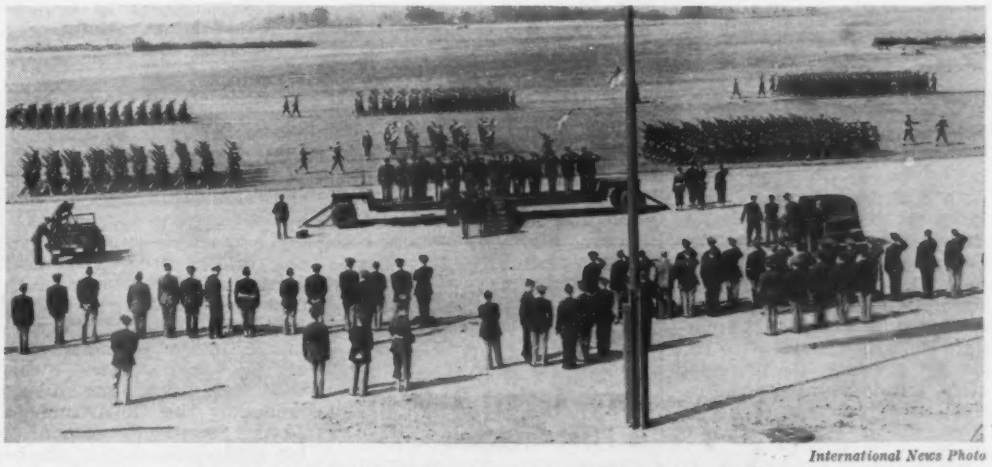
Robert E. Gross, president of Lockheed, emphasized that "while all of our efforts and facilities currently are dedicated to the single purpose of building airplanes to help win the war, we must look forward to the day when our industry will have new responsibilities to our nation's society and economy."

There were indications in the action that Lockheed was preparing to manufacture private airplanes when peace comes, possibly through its Vega subsidiary, and would, at the same time, continue peacetime activities in the air transport field.

Concurrently, it was also indicated that Lockheed would shortly offer $15.25 a share to Pacific Finance minority common stockholders. After retirement of the common shares, Lockheed's investment in the company will

Warner Envisions Europe Service

Half a dozen or more flights a day each way between London and the Continent and New York in planes holding up to 57 passengers, mail, and freight have been predicted by Edward P. Warner, CAB vice-chairman, in the 31st Wilbur Wright Memorial Lecture delivered before the Royal Aeronautical Society in London. He envisioned flying time of 15 hr., fares of about $100 one way, a fatality rate of only one person per 100,000,000 passenger-miles, and on-schedule dependability of 91 to 97 percent in winter, 99 percent in summer.

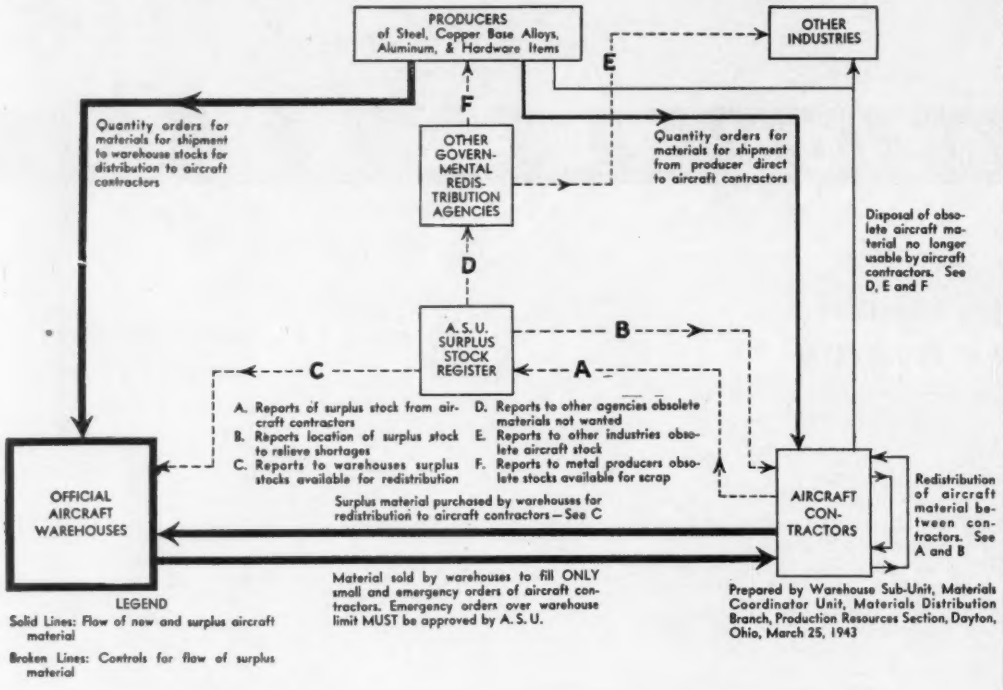


International News Photo

FIRST YANK-BUILT BRITISH BASE NAMED FOR ANDREWS

Troops pass in review during dedication of first American-built air base in England. Named Andrews Field in memory of the late Lt. Gen. Frank M. Andrews, U. S. Army European theater Commander, the base was completed in ten months by Army engineers and other technicians working 24 hr. a day, 7 days a week.

FLOW OF MATERIAL THROUGH OFFICIAL AIRCRAFT WAREHOUSES


PRODUCERS of Steel, Copper Base Alloys, Aluminum, & Hardware Items
OTHER INDUSTRIES
E
F
Quantity orders for materials for shipment to warehouse stocks for distribution to aircraft contractors
OTHER GOVERNMENTAL REDISTRIBUTION AGENCIES
Quantity orders for materials for shipment from producer direct to aircraft contractors
Disposal of obsolete aircraft material no longer usable by aircraft contractors. See D, E and F
D
A. S. U. SURPLUS STOCK REGISTER
B
C
A
A. Reports of surplus stock from aircraft contractors
B. Reports location of surplus stock to relieve shortages
C. Reports to warehouses surplus stocks available for redistribution
D. Reports to other agencies obsolete materials not wanted
E. Reports to other industries obsolete aircraft stock
F. Reports to metal producers obsolete stocks available for scrap
OFFICIAL AIRCRAFT WAREHOUSES
Surplus material purchased by warehouses for redistribution to aircraft contractors — See C
AIRCRAFT CONTRACTORS
Redistribution of aircraft material between contractors. See A and B
Material sold by warehouses to fill ONLY small and emergency orders of aircraft contractors. Emergency orders over warehouse limit MUST be approved by A. S. U.
LEGEND
Solid Lines: Flow of new and surplus aircraft material
Broken Lines: Controls for flow of surplus material
Prepared by Warehouse Sub-Unit, Materials Coordinator Unit, Materials Distribution Branch, Production Resources Section, Dayton, Ohio, March 25, 1943

WPB Enlarges Steel Warehousing Program

Four changes have been announced in the aircraft steel warehousing program which WPB's Steel Division has expanded to solve material shortages. They are: (1) increase in the number of steels carried by warehouses, in some cases as much as five times; (2) same amount of material which previously could be shipped quarterly may now be dispatched monthly; (3) manufacturers may issue blanket certificates to cover all future orders on warehouses; (4) warehouses have been increased from 16 to 26 in eleven states.

"The purpose of the program," it is announced, "is to supply aircraft manufacturers with both their small and emergency requirements of critical alloy steels. It will also serve in redistributing surplus alloy steels." Steels may be used only for aircraft and not for jigs, fixtures, or ordinary ground equipment "whether or not this equipment might be flown to an advanced base."

Warehouses may release steels in three ways only: (1) to manufacturers of approved parts, (2) to modification centers and Army and Navy supply depots, and (3) to maintain or repair aircraft or air-borne equipment. Manufacturers should file with the nearest warehouse a blanket certification of authorized needs, which must be within limits set by Earmarked Stock Directive No. 6 for any one month.

If the requested steel is not stocked but on order, Procurement District offices may certify the need as emergency, and the Aircraft Scheduling Unit will then order the warehouse receiving the steel to ship it even though pre-dated orders for the same material have been accepted. One warehouse will carry nonstandard items, but production of those not stocked will be authorized by the Scheduling Unit "only in very exceptional cases." Manufacturers are urged to make full use of welded tubing since seamless tubing production facilities are limited.

Warehouses will not hold lots for purchase orders more than seven days and will be notified by the Scheduling Unit when manufacturers have surplus stocks which they have been instructed to purchase.

Except for two cases where these warehouse materials may be shipped to Canada, their use is restricted to the continental U. S.

amount to approximately $3,750,000.

The Pacific Finance board named Robert Gross, Courtlandt S. Gross, Charles A. Barker, Jr., Cyril Chappellet, and Corson W. Ide directors to fill existing vacancies. Resolutions were adopted for a special meeting of the corporation's stockholders to call Series A and C preferred stock and to authorize the reduction of capital by the retirement of 182,852 common shares.

Mr. Barker, vice-president and treasurer of Lockheed, who handled the negotiations for the aircraft company and who was elected chairman of the board of the finance company, commented that "one of the compelling factors in this purchase was the excellent staff and management of the Pacific Finance Corporation, which, under the able direction of Mr. Maxwell King, as president, will continue to operate the company."

Warns Against Monopoly In Plant Disposals

A warning that non-monopolistic disposal of war plants now owned by the government is more important than possible high prices that may be got for them is contained in a memorandum prepared for Sen. Millard E. Tydings, chairman of a special committee on federal fiscal matters, by Robinson Newcomb, chief of the program analysis section of WPB where the report has also been circulated.

Pointing out that a great many aluminum plants "have already been given away," thus continuing the alleged monopoly the Department of Justice considers responsible for slow production at the beginning of the war, Mr. Newcomb urges that facilities be distributed so as to foster rather than to restrict competition. Selling to the highest bidder, he fears, may give big companies the opportunity to acquire plants they do not need.

Five Kinds of Planes Seen in Postwar Use

Postwar flying will be divided into three development periods, and one of them will see the introduction of five kinds of planes for different types of service, it was declared by Charles Froesch, chief engineer of Eastern Air Lines, at a recent New York meeting of the Society of Automotive Engineers.

Between the transition phase "from the wartime mobilization of the airlines to normal commercial operation" and the development era "which will establish the air transport industry as big business," said Mr. Froesch, there will be a four to six year "intermediate period of readjustment and expansion." Declaring that "the day of transport airplane standardization is over," Mr. Froesch predicted that the following kinds of planes would be used during the intermediate period:

(1) A small capacity feeder service plane to make stops every 25 or 30 mi. and capable of landing and taking off "from any 1,500 ft. square cow pasture." In sparsely populated areas or where terrain is bad helicopters might be substituted.

(2) A larger plane connecting with the feeder service to make stops every 100 to 200 mi.

(3) "An airplane of excellent speed performance" and maximum payload operating limited stops from modern airports.

(4) A big plane with large passenger and freight space "designed for 1,000 mi. and upward runs between stops."

(5) "A flying box car" for freight service "able to stand a lot of abuse."

★ SPOT CHECKING ★

Robert M. Hutchins, president of the University of Chicago, declared in a recent talk that aviation's shrinking of distances does not necessarily promote understanding among nations. "Either we grant that we are doomed to perpetual war because no common ideals are possible," he says, "or we exert ourselves now to discover what our ideals should be and how to make them the common aspiration of the peoples of the earth."

Lt. Gen. George H. Brett, chief of the Caribbean Defense Command is to be made Knight Commander of the Order of the Bath through

the British minister in Panama. Maj. Gen. James H. Doolittle, commander of the Strategic Air Force in Northwest Africa, has been given the Army's Silver Star for "his untiring energy and initiative." Maj. Gen. George E. Stratemeyer, chief of AAF staff, has received the Air Medal for completing "a secret mission which carried him into most of the active theaters of operation" between Apr. 8 and June 5.

Answering a CAB questionnaire, the Port of New York Authority maintains that New York City should be a major embarkation point for postwar overseas air services. As evidence of need, the Authority points out that passport statistics show that 61 to 67 percent of peacetime travelers live in the Northeast. Simultaneously Col. Harold R. Harris revealed that "hundreds" of men for ATC's Domestic Transportation Div. are being trained in the New York area.

A "trouble shooting" department to advise employees with rationing problems has been organized by Eclipse-Pioneer Div. of Bendix Aviation Corp. The home town of the company, formerly Bendix, N. J., has been renamed Teterboro by unanimous vote of 17 of its 40 residents.

German version of our Army-Navy "E" has been given to 95 Nazi plants. Even so, the Nazis admit that Allied production exceeds theirs.

T. P. Wright, director of the Aircraft Resources Control Office, has testified before the Senate Military Affairs Committee that the aircraft industry will need 2,300,000 workers by Apr., 1944, 700,000 more than it employs now.

Natural and synthetic rubber consumption throughout the world after the war may reach 2,000,000 tons annually, nearly twice as much as any year to the present, estimates John L. Collyer, president of B. F. Goodrich.

Dow Chemical Co. announces organization of a department to develop new products.

Commercial Research Div. of Curtis Publishing Co. (*Sat. Eve Post*) has issued a study on factors affecting aviation, postwar circumstances, and methods of improving the industry's position in the transportation field.

Hudson Motor Car Co. announces that production of aluminum pistons and parts for Wright *Cyclones* "currently is running two and a half times the originally contemplated maximum."

CAP's HQ to New York

Headquarters of the Civil Air Patrol has been moved from Washington to 500 Fifth Ave., New York, in accordance with the policy that agencies which can function elsewhere should be transferred from Washington. About 12 officers and 40 civilians are making the move. Commanding Officer Lt. Col. Earle L. Johnson, Operations Officer Col. Harry L. Blee, and Intelligence Officer Capt. Kenneth Hoyt will be stationed at the new address.

★ FOR THE RECORD ★

Black Bear Co., has opened a separate office for its Aviation Division at 620 Fifth Ave., New York City.

Aerovox Corp. of New Bedford, Mass., has opened a 60,000 sq. ft. plant in Taunton for production of mica capacitors.

V. W. Farris, formerly general manager of Kieley & Mueller, Inc., has formed the Farris Engineering Co. which will soon announce a line of remote control devices for both aviation and maritime fields. Company is occupying a new plant at Ridgefield, N. J.

MECHANICS GET THEIR "WINGS"

Built from salvaged P-40 parts, this "taxi trainer" is being used to instruct AAF mechanic candidates in ground handling of fast planes at Curtiss-Wright's training camp in Buffalo. It was developed there by Technical Training Command officers, who took away its ability to fly and substituted an extra cockpit, dual controls, a communicating system, and a front wheel to prevent nosing-over.

The Washington Windsock

By BLAINE STUBBLEFIELD

The Stubblefield Award is bounced right back, this month, to the Windsock department itself. After going into hysterics, the judges gave the coveted bauble to us for filing an application with CAB for the longest airline on earth. We start at New York and go to Buffalo by way of Glasgow, Moscow, Tokyo (without asking Joe or Tojo) thence to the Arctic, where we give the passengers a pleasure whirl three times around the world one mile from the North Pole, thence to Enterprise, Ore., where we have relatives—and then, finally, to Buffalo. Our equipment is a fleet of wingless, engineless, rotorless, rocketless skycars which fly 8,000 mi. consuming only three soy beans. And now we'd better pause here and advise everybody to stop day dreaming.

Postwar liquidation of plant and equipment will be a problem second only to the war itself in magnitude. Billions of dollars worth of trucks, cars, machine tools, ships, boats, locomotives, and other goods which will be perfectly serviceable in peace will have to be disposed of. Biggest item of all will be airplanes, especially cargo planes, convertible to commercial service. If all this equipment is sold cheap to people who need it, the manufacturers of such goods will be seriously set back. Yet, it would seem the height of folly to scrap serviceable goods. Every conceivable proposal will be made, including one that all of it be exported. Several over-all plans are before Congress in the form of bills. But aviation, having become the biggest program in the war, feels it cannot be justly handled in a blanket plan of liquidation. Special plans will soon be proposed.

You will hear more about the seadrome situation. Penn-Central Airlines at this writing had not actually filed an application for a trans-Atlantic drome-to-drome route; it had only announced intention to file. In any event, the floating intermediate station idea is not to be summarily dismissed. From an operating point of view, no matter how efficient long-range planes become, short runs between fuel stations will always enable them to carry bigger loads at lower rates. When the time comes for a decision, the question will be whether any one company should own seadromes, or whether they should be nationally or internationally owned and operated. It is a safe guess that, if they turn out to be practical, they will be spotted over the seven seas.

People are talking helicopters everywhere you go in Washington. You get the feeling that, so far as Joe Doe and his wife are concerned, the real flying age will be born some time in the late '40's. Joe and his spouse are now imagining themselves doing everything in helicopters from picnicking on top of Mt. Rainier to sowing wheat on the farm. Of course, talk's already arisen about the "ogre of congested traffic." But this is just folklore. Figuring an airway 5 mi. wide by 3,000 ft. high, you could have millions of ships in the air between two points a hundred miles apart, and with plenty of room between them. However, there will be parking lot trouble, if people still live in concentrated groups.

Cut-back orders are coming. They have already hit several types of artillery, tanks, mobile field equipment, machine tools, anti-aircraft guns, and some types of airplanes. The day will come—no doubt taking many people by surprise—when the whole aircraft program will be cut back. It would be foolish to predict specifically, but an interesting guess puts it right before, or soon after, Hitler folds up. At that time, scores of thousands of planes can be pulled out of Africa, England, and wherever else they may be by then. There will be thousands in the "pipeline" on the way to the front, and other thousands pouring off the assembly lines here and in England. There's Russian production, too. The Japs must know that this monstrous force is coming against them. One wonders what they think about it.

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Case of H. R. 1012

By BLAINE STUBBLEFIELD

Washington (AVIATION Bureau)—H. R. 1012, a re-draft of the Civil Aeronautics Act of 1938, introduced by Rep. Clarence Lea of California and sponsored by the Civil Aeronautics Board and the Air Transport Association, probably will not be acted upon until after Congress recesses in July and August.

A House Interstate and Foreign Commerce sub-committee has reported the bill back to the full committee, which is holding more hearings before offering it to the House. An identical bill has been introduced in the Senate by Sen. Joseph Bailey of North Carolina. But the Senate will probably accept the House-revised version.

The civil aeronautics law has been accumulating legal obsolescences, due to rapid growth in the nation's airway system. The prospect of unusually rapid development immediately after the war moved the board and the Administration early this year to ask for the revision. It is expected that the airline system will expand from 8,000,000 traffic movements in 1942 to about 60,000,000 in 1950.

Mr. Lea's first draft of H. R. 1012 was sidetracked when another bill by Rep. Jack Nichols of Oklahoma was introduced, proposing the creation of a new committee in the House to handle all aviation matters.

But the Nichols bill failed for several reasons, chief among them the fact that the old and powerful Interstate and Foreign Commerce Committee, which is headed by Mr. Lea, did not want to lose jurisdiction over aviation. Another reason for the rejection was that some congressmen feared Mr. Nichols would become chairman of the new committee with Rep. Ham Fish of New York possibly in line for the seat. Although little opposition was offered publicly to Nichols' investigation of air crashes, neither the Civil Aeronautics Board nor the air transport industry liked it; they felt that it duplicated regular studies provided by law and performed by trained men.

Probably the question of independent aviation committees in the House and Senate will not come up again for a while. Meantime, the Lea group is likely to rule the air legislation roost during the important domestic and international developments ahead.

There is no controversy over the provisions in the Lea bill that the board investigate proposed delivery of all mail by air except what can be delivered just as quickly by other means; that the board study an over-all postwar program; that it push development of all civil aviation, tighten down still further on free passes, give captains more authority over airplanes in flight, and study and report on aviation insurance.

Other provisions, however, are intermeshed with old controversies. Chief among these is states rights. Among the rights of states, as seen by state officials, is control of intra-state air traffic, control over state lands, jurisdiction over deeded lands, and control of air space over the state. State officials do not like the proposed further federalization of private contract, and scheduled air transport; neither do state aviation societies. Operators in states that have favorable air laws would like to keep the present system while others, who feel that they are being misused, would like to get under federal control. Sponsors of the Lea bill argue that the few operations still within state borders are actually in interstate commerce.

One of the hardest problems is the zoning of airports. Large areas around many major air terminals must be cleared of obstructions. Quite often clearance interferes with private property of state citizens. The bill, as presently written, empowers the Administrator to ask local governments for cooperation. But what if the cooperation is not forthcoming?

H.R. 1012 aims to forestall multiple taxation of airline properties and equipment by the states. This is to prevent a recurrence of the recent case in which Minnesota slapped a tax on all of Northwest Airlines' planes passing through the state. Otherwise, the bill leaves unsolved the question of allocation of taxes for the support of airports among the airlines, the areas served, and the federal government. Indeed, this problem probably is not within the scope of the bill. This is one of the most tangled issues in aviation and back of it lies the need for a decision on whether the government wants to support the airline system, at home and overseas, as the nucleus of a military air transport organization, or to hold it to a profit margin basis, as at present. That question is resting heavily on many an official mind.

Disposition of the Lea legislation also depends to some extent upon what policies may be developed by the interdepartmental aviation committee which is now trying to work out an international air policy for the United States. There is always the possibility that Congress or the President will attempt to set up a super air group of some kind leaving the present board and Administrator in subordinate positions.

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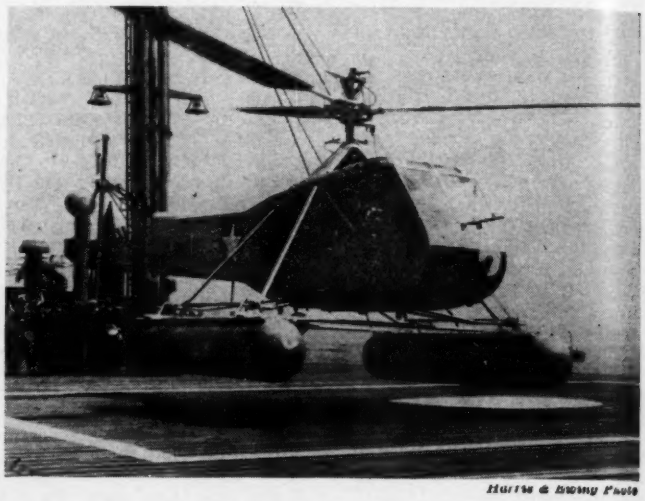


Hurlbut & Ewing Photo

Following successful demonstrations that helicopters can take off and land from the deck of a freighter, Rear Admiral Howard L. Vickery, vice chairman of the Maritime Commission, announces that Liberty ships will be equipped with small decks which "will permit helicopters to be used at sea, giving ships added protection from submarines."

The demonstration, sponsored by the Maritime Commission and the Army, was made recently in Long Island Sound, where Col. H. F. Gregory of the AAF Materiel Command, Wright Field, made 24 take-offs and landings with a Sikorsky SV-300 from a freighter traveling at various speeds. With floats installed on the helicopter for water operation, Col. Gregory maneuvered it into a space 78x48 ft. Since there is no propeller noise and the sound of the motor can be muffled, helicopters can fly at night with no tell-tale noise.

Further projected uses of helicopters were revealed by Brig. Gen. David N. W. Grant, AAF air surgeon, in a speech before the American Medical Assn. disclosing that the Army has practically ready for operation helicopters with two litters for evacuating wounded. The problem of the four-litter helicopter, Gen. Grant said, is "pretty well licked."

Family Plane Boom Scouted by Vaughan

Family planes and superairliners will not be as prevalent immediately after the war as the public believes, in the opinion of Guy W. Vaughan, president of Curtiss-Wright Corp., who points out that high postwar taxes will necessitate sacrifices. Affected, he says, will be the predicted boom in private planes.

Truman Will Report On AAF Engine Failures

Washington (AVIATION Bureau)—It is revealed that the Truman Committee will shortly issue a report covering its investigation of engine failures in AAF operations. No hint of the findings, however, will be available from the Committee until all the information is assembled, analyzed, and released.

Meanwhile, the Army is making a study of its own, with Gen. William S. Knudsen heading the job. It is not known whether the Army will eventually issue a report.

Refusing to comment on causes or remedies, Truman Committee spokesmen merely say that the information will go to the War Department as fast as they get it. They point out meanwhile that the AAF is doing everything it can to bring about improvements without awaiting completion of the investigation.

★ Military Memos ★

For every Nazi bomber over Britain in May, the English sent 40 over Germany. Since 1940, the Germans have dropped 69,000 tons of bombs, the British 140,000, according to estimates.

By fuel, range, and altitude modifications on **Flying Fortresses** and **Liberators**, AAF has increased their bomb load from about four to ten tons. Two-ton block-busters are now carried under each wing of both planes.

Gen. Arnold announces that 1,800 planes were flown across the Atlantic and Pacific during May. On one day alone 100 planes left Labrador's huge fields for England.

Our Eighth Air Force in England has doubled since March and will, it is stated, be redoubled between now and October. Losses are said to be well under 5 percent.

Calling Names

Clyde M. Vandeburg is now general manager of the East Coast Aircraft War Production Council.

Richard M. Mock is new vice-president and chief engineer for Lear-Avia, Inc.

George E. Leaf has been named paymaster in charge of Northwest Airlines' entire payroll and time-keeping system.

George F. Held, former newspaperman and A. P. reporter at LaGuardia Field, has been named eastern regional manager of the public information department of TWA. This line also announces that **Ernie Smith,** former air transport pilot, trans-Pacific flyer, and district traffic manager at San Francisco, has been made assistant to **Traffic Mgr. Conroy.** He will be succeeded at San Francisco by **Joseph W. Morris.**

Walter T. Johnson is now safety engineer for American Airlines. Working under the direction of the plant engineer, he will concern himself with the safety of personnel and passengers and will be responsible for the technical supervision of the organization.

John K. Hilliard, chief transmission engineer of M-G-M sound department and recently consultant to the Radiation Laboratories of M.I.T., has joined the war production staff of Altec Lansing.

Jack Nichols, member of Congress from Oklahoma, has been elected to the vice-presidency of TWA. He will take up his new work following his resignation from Congress.

Alfred Marchev, vice-president of Republic Aviation and general manager of the Long Island plant, is now executive vice-president, a newly established post. In his new work, he will assume responsibility for the Indiana plant's operation as well.

Edward P. Warner has been made an Honorary Fellow of The Royal Aeronautical Society.

C. C. Codding is new general manager of Aircraft Parts Mfrs. Assn., West Coast.

Robert R. Nadal, Lt. (jg) USNR, general sales manager for Culver Aircraft, is on leave of absence for the duration.

W. H. Houghton has been elected treasurer and **Arthur E. Raabe** v.p. and group executive of Bendix Aviation.

Bert Conway, formerly with General Motors, has been named manufacturing coordinator for the Aviation Corp.

C. P. Shropshire, traffic manager at the Nashville division of Consolidated Vultee, who has been on special assignment with the AAF since last October, has completed the assignment and returned to his job.

Fred L. Hall, for the last six years sales manager of Bendix-Westinghouse, has been appointed v.-p. in charge of sales for Rogers Diesel & Aircraft Co.

Charles L. Tanner, manager of Hard Chrome Engineering Co., has been elected membership chairman of the Aircraft Parts Mfrs. Assn.

Frederick R. Lack has been elected a v.-p. of Western Electric.

Mary Estill has left her TWA Link trainer instructor job at LaGuardia Field to report to a Texas base of the WAFS.

Rex B. Beisel has been elected general manager of the Chance Vought Aircraft Division of United Aircraft. He has been acting general manager of the division for the past several months.

Emery Johnson is now in charge of Aircraft Accessories' new Washington office.

Arthur W. Larson has been named director of purchases for all divisions of Consolidated Vultee, while **Frank A. Learman** has been appointed general sales manager.

Mary Ellen O'Connor, dubbed "flyingest woman in the world" on her record of approximately 2½ million miles of flying, leaves United Air Lines to become a Navy nurse.

Jerome V. Roscoe, asst. to V.-P. and General Traffic Manager Chenea of Pan American Airways, transfers to the position of acting asst. division manager of the Alaska division; **J. E. Crosson** resumes his post as manager of the division; **L. C. Reynolds** is reassigned to N. Y. as executive asst. to **V.-P. Bixby;** and **O. J. Studeman** becomes operations manager of the division.

Ryan Aeronautical announces the following changes: **Mel Thompson** is the new assistant to **Eddie Molloy,** v.-p., and is replaced by **Ray Clever** as service manager; **J. E. Cooper,** formerly with Consolidated Vultee, becomes assistant to **E. A. Moore,** production supt.; **J. T. Zihlman,** formerly of Goodyear, is now assistant to **G. E. Barton,** factory manager, and **W. Dow Woodward,** previously with Curtiss-Wright, is contract coordinator under **Walter Locke,** Ryan contract administrator.

Richard D. LaFond has been named director of public relations for Sperry Products.

Lee Schoenfeldt, former economist and manager of commercial research for General Electric, has joined the radio division of Bendix Aviation as asst. marketing director.

Anne Means is now publicity writer on air express traffic for American Railway Express.

Samuel Mecutchen has been named safety engineer for Kellett Autogiro.

W. C. Deeds has joined the executive staff of the Duramold division of Fairchild and will be concerned with production supervision.

W. Frank Persons, former head of the U. S. Employment Service, and recently director of industrial relations for Consolidated Vultee, has joined Ryan Aeronautical as head of its newly-organized industrial relations department.

Ralph O. Proctor, for the past two years office manager for WPB at San Diego, has been appointed chief field engineer and asst. to the general manager of the Malabar Machine Co.

Thomas A. Morgan, Sperry president, has received the honorary degree of Doctor of Science from Duke University.

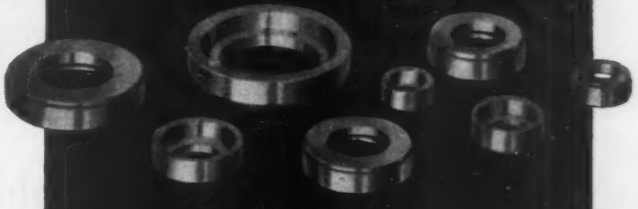
J. R. Allen, administrative engineer for Simmonds Aerocessories, has been appointed asst. chief engineer.

Robert T. Phinney has been appointed northern division traffic manager for Braniff Airways.

John E. Wells has been named advertising manager of the Aviation Corp.

THREADED TAPER PINS

High-strength nickel steel taper pins, generally used in aircraft construction. Used with special washer (see below) and a thin slotted or self-locking nut. Ordinarily furnished drilled with cotter pin hole. Made of WD2330 nickel steel in accordance with Army-Navy Specification AN-QQ-S-629. Centerless ground after hardening, and cadmium plated.



TAPER PIN WASHERS

Ordinarily, these are a screw machine product, but ours are stamped. Thus we are able to provide accurate, uniform washers with prompt delivery and at lower cost. Compare our prices! Made from high quality steel and cadmium plated to Army-Navy Specification AN-QQ-P-421. *Sizes to fit all popular taper pins in stock. Four weeks delivery on sizes not in stock.*

We are Specialists . . .

in the manufacture of selected items of aircraft hardware. In addition to the above, we can furnish high quality Drilled Head Aircraft Bolts, Drilled Fillister Head Machine Screws, Hexagon Head Bolts, Clevis Bolts and Pins, Washer Head Screws and Precision Studs.

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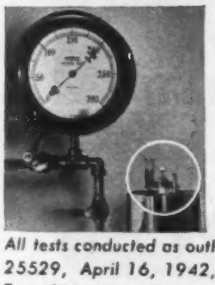
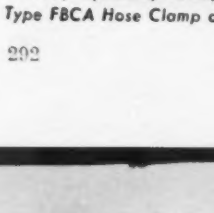
Performance Plus!



EXCEEDS LEAK TEST REQUIREMENTS—Pressure of 210 lbs. per square inch applied inside hose *without leakage*



EXCEEDS WRENCH TORQUE REQUIREMENTS—Tested at 118 lbs *without failure* to any parts.

EXCEEDS STRENGTH REQUIREMENTS—Load of 2970 lbs. imposed on clamp *without failure*

All tests conducted as outlined in Army Specification 25529, April 16, 1942, and made with Wittek Type FBCA Hose Clamp and 1-inch ID hose.

Republic P-47 Thunderbolts Equipped With Wittek Aviation Hose Clamps

For Dependable Hose Connections

On the offensive—with new weapons for allied victory—P-47 Thunderbolts! These fast firing heavily armored high altitude fighters are equipped with Wittek Aviation Hose Clamps. Today, as in the past, Wittek Aviation Hose Clamps, known as the standard of the industry, are being used by the nation's leading military aircraft and engine builders. Wittek Manufacturing Co., 4305-15 West 24th Place, Chicago.

...BUY MORE WAR BONDS...

ARMY E NAVY

WITTEK *Aviation* **HOSE CLAMPS**

First Quarter Aircraft Production: Numbers Look Good, but Pounds Count

Washington (AVIATION Bureau)—Production of planes and armament increased eight percent in April, measured on a dollar-weight basis. Output of heavy bombers, ten percent of total output, went up 18 percent, and single engine Navy fighters increased nearly 50 percent. May output exceeded 7,000 units and the April number was double last year's. WPB Vice-Chairman Wilson called for 8,000 in June. Some officials said they thought the request could be met.

Nevertheless, the aircraft program did not quite meet objectives laid down for April. Total expenditures for the month were $1,649,000,000, which was 33 percent of all munitions produced. Output of aircraft ordnance was 14 percent ahead of the March record, largely because of the great increase in the manufacture of heavy bombs.

Over-all munitions output in April advanced seven percent over March and was just under the five billion dollar mark. A few categories lagged badly behind schedule.

The War Production Board frankly admits that the program laid out for 1943 will be most difficult to attain. In the first third of the year, only 19 percent of the year's combat plane program had been completed, 20 percent of service planes, and 36 percent of trainers—which puts the latter slightly ahead of schedule.

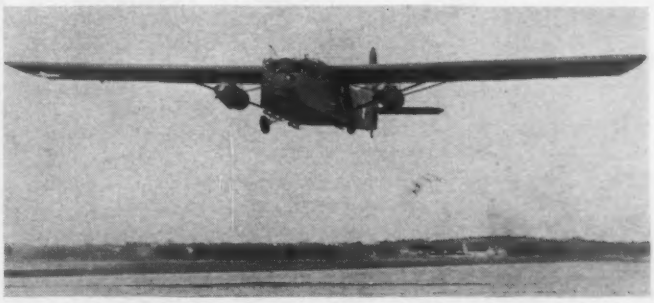
This lag is caused chiefly by the continued move into greater volume of heavy bombers, double last year's output and necessitating construction of several new plants. Whether the 1943 goals can be reached depends upon the speed with which the heavy bomber facilities can be completed and put into operation. It is partly slowed by continuous dis-balances such as the recent shortage of aluminum and magnesium forgings, castings, and extrusions.

Latest opinion is that our maximum production will be reached about the first of 1944. It is probable that the press and the public will continue to talk numbers of planes, but the only accurate quantitative measure from now on will be pounds, not units.

The President himself took the lead the other day in trying to stop the numbers talk by saying that we will produce an estimated 911,000,000 lb. of aircraft in 1943. The total weight produced in April this year was three times that of last April. But the average weight of a plane this year is about 30 percent greater and by next year will be almost 60 percent.

Power Glider Given Tests at Wright Field

Undergoing official Army tests at Wright field is the first standard type CG-4A glider to be equipped with engines capable of providing power for take-offs and sustained flight. Army officers were reticent to discuss the ship's effect on tactics, but it was clear that self-propulsion would obviate the necessity of packing and shipping the gliders from factory to front and would also increase the number that can be strung out behind a tow-plane.



Northwestern Aeronautical Corp.'s powered CG-4A glider takes off under its own power. Col. Fred R. Dent, who cooperated with company engineers in installing the 130-hp. engines, was at the controls.

Motor installation details were worked out by engineers of Northwestern Aeronautical Corp., which has been building the gliders in Minneapolis for several months, and Col. Fred R. Dent, director of the experimental glider program at Wright Field. The six-cylinder, horizontally-opposed engines are 130 hp. each and were built by Aircooled Motors Corp., Syracuse, N. Y. Designed for attachment or removal in an hour, they somewhat reduce the glider's load capacity of 15 men, a jeep and its crew, or a 75 mm.-field gun.

Furniture Firms Will Build Light Plane

Patent licenses, finished planes, and parts inventories of the *Skyfarer* have been acquired from its maker, General Aircraft Corp., South Lowell, Mass., by Grand Rapids Industries, a group of 15 of that city's leading furniture manufacturers, who plan "immediately" to build a plant at the Grand Rapids airport, where parts for planes, made in their factories, "will be essembled and the completed plane flown to its owners."

This move, says a spokesman for the group, "marks the permanent bid on the part of Grand Rapids furniture manufacturers to occupy a prominent and permanent place in the aircraft industry." Grand Rapids Industries, organized in 1942, has been producing wooden parts for CG-4A gliders, B-29 bombers, and the Stinson *Sentinels*.

The *Skyfarer* was designed by Prof. Otto C. Koppen, formerly of Massachusetts Institute of Technology, and the Grand Rapids buyers announce that they "will engineer its unique safety and simplified control features for military use and develop luxury features" for postwar appeal, particularly to Air Force veterans. They describe its construction as embodying "a simplified unit control system, trycycle landing gear mounted in hydraulic shock absorbing struts, wing flaps, and other patented aerodynamic principles." It is said that the CAA has called the ship incapable of spinning.

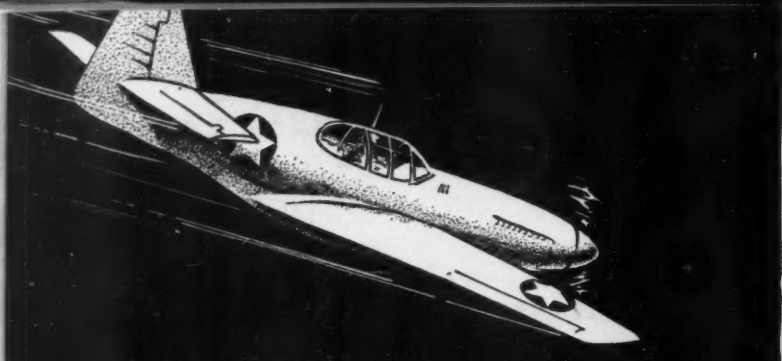
Frederick H. Mueller, president of Grand Rapids Industries which has acquired rights to produce the "Skyfarer," points out the small plane's control features.

OWM Will Have Little Effect on Plane Makers

Washington (AVIATION Bureau)—As it stands now, the newly-organized Office of War Mobilization, of which Justice James F. Byrnes, formerly director of the Office of Economic Stabilization, has been appointed chief by Pres. Roosevelt, will have little effect on aircraft producers who are having less and less trouble getting everything they need.

A group of leaders in Congress, representing both parties, has long advocated a super war agency, and the White House has shown no interest. OWM is not actually a war mobilization agency; it might become one under certain circumstances, but probably will not.

Justice Byrnes is authorized to do two jobs: (1) develop a unified program for all phases of the civilian war effort by making basic allocations of materials, manpower, transportation, and plant capacity and (2) to function as umpire, settling disputes between agencies and industry bosses (food, rubber, oil, aircraft, power, etc.).



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First TO LICK LOW TEMPERATURES

Tested to 90° below zero Ceco pumps function satisfactorily under all operating conditions . . . battle tested in combat, these pumps will contribute much to peace-time transportation.

Chandler-Evans Corp.
SOUTH MERIDEN, CONN.

Wilson Wins Advisory Committee On Problem of Aluminum Extrusions

Washington (AVIATION Bureau)—The men who make the nation's airplanes and those who have the responsibility for delivery of materials and components are still not in complete accord despite a three-day meeting here called for the express purpose of ironing out the differences.

With the military calling for more and more planes, the War Production Board has been hard pressed and, in turn, has been bearing down on the manufacturers. The result was natural, a breaking of tempers and an exchange of uncomplimentary remarks.

Aided and abetted by the Army, the move was made to relieve Charles E. Wilson, chairman of WPB's Aircraft Production Board, of the materials scheduling program. Wilson was adamant and held his ground. The upshot was the formation of a planning and production committee to speed assignments of materials and components for plane production, which even the most ground-fettered officer now admits is the spearhead of the war effort.

Wilson, speaking for WPB, contends that there are now no serious bottlenecks in airframes, engines, and propellers. There are, however, delivery delays in forgings and extrusions, a problem that aeronautical engineers have been working on for months. There have been, too, some shortages of components such as hydraulic systems, pumps, motors, air systems, generators, and some parts. Mr. Wilson made no mention of these in his recent statement, but the industry is well aware of them.

Aluminum extrusions were the center of most of the sharp words passed back and forth at the meeting. The problem is not a new one and has persistently plagued the manufacturers.

Wilson's plan to relieve the extrusion shortage centers around incentive pay and other methods of a like nature, but even so the outlook is not good for any more than barely enough. The problem is most complex since there are nearly 10,000 types, although the Aircraft Standards Committee, which operates through the Aeronautical Chamber of Commerce, has taken steps to reduce the number. Extrusions have been handled as "controlled materials" under the Controlled Materials Plan, through which manufacturers could take an allotted poundage in any form needed.

Under the new set-up, developed at the meeting, extrusions are now labeled "critical components." Manufacturers must report their stocks by type and size, in-process inventories, and future monthly requirements. These, if all works well, will be correlated with estimated capacity, and production scheduling will be laid out for all extruding presses. Each aircraft producer will have a definite delivery schedule.

U&M Photo

Chairman of the new advisory committee on planning and production is Arthur H. Bunker, chief of WPB's aluminum and magnesium branch.

Overseeing this program in an advisory capacity will be the new planning and production committee. Its chairman is Arthur H. Bunker, chief of WPB's aluminum and magnesium branch, whose decisions will be backed up by directives from Mr. Wilson when necessary. The committee's chief job will be to study requirements for and standardize types of forgings, castings, and extrusions so that facilities can be cut back and still give plane manufacturers an even flow of materials.

Roebling Establishes New Aircraft Division

The Aircord Division, a separate department to serve the aircraft industry, has been established by John A. Roebling's Sons Co., Trenton, N. J.

"This new division," says the company, "will make available through a single source the complete line of Roebling products for aircraft as well as the Roebling engineering and consulting service. The move was made necessary by the growing needs of the industry and the increasing part that Roebling is playing in it."

Manager of the Aircord Division will be Forest S. Burtch, previously assistant chief engineer of the company's wire rope department. Mr. Burtch has participated in many developments of aircraft cables and controls, among them the Lock-Clad

cord on which he worked with Lockheed engineers. He has been with Roebling since 1923.

Coast Tubing Plant

Construction is under way in Los Angeles on a $1,750,000 factory which will manufacture the first ferrous and alloy tubing to be produced in the western half of the United States. It is expected to cut 85 to 90 percent off the time now required to make and deliver 1,400 different sizes and gages of metal tubing used by Pacific Coast airplane and other war plants. The new plant will be operated by the Pacific Tube Co. C. A. Warden, Sr., is president.

Production-Battle Citations

*** * * * Two Stars * * * ***

BAKELITE CORP. (Bound Brook, N. J.)

*** * * * One Star * * * ***

INTERNATIONAL RESISTANCE CO.
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Army—Navy "E"

AGAWAM AIRCRAFT PRODUCTS
AMERICAN BRASS CO. (Kenosha Brass Co.)
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THE AVIATION CORP. (Republic Aircraft Products Div., Detroit)
CURTISS-WRIGHT CORP. (Propeller Div., Beaver, Pa.)
DEFIANCE AUTOMATIC SCREW CO.
E. I. DUPONT DE NEMOURS (Perth Amboy, N. J.)
HUGHES-KEENAN CO.
LINK-BELT CO. (Ewart Works, Indianapolis)
MCQUAY-NORRIS MFG. CO.

Assembly Lines

Bureau of Standards says it has advised Army engineers that Bessemer steel is ideal for runway landing mats.

Absentee report cards are being placed in time-card racks in Curtiss-Wright Buffalo plants. Returning from an absence, the employee states the reason on the card and drops it in a box. The information is for the enlightenment of government researchers only.

WPB urges resharpening of hand files; it adds 60 percent to a file's life at one-third to one-half the cost of a new one with an estimated saving of 600 tons of high carbon steel and many man-hours.

Agents of the Board of Economic Warfare in Equador have been directed to make spot purchases of balsa wood for planes and life rafts. The business was in the sole hands of six importers.

Order M-279 gives details of WPB's new specifications and grading rules for yellow poplar aircraft lumber.

Congressmen complained that if Andrew Jackson Higgins built his proposed plywood plant to speed manufacture of Curtiss C-76's, output of other plants would suffer for lack of manpower and materials. But WPB ordered Higgins to go ahead—after he sent a 3,500- word telegram to Washington.

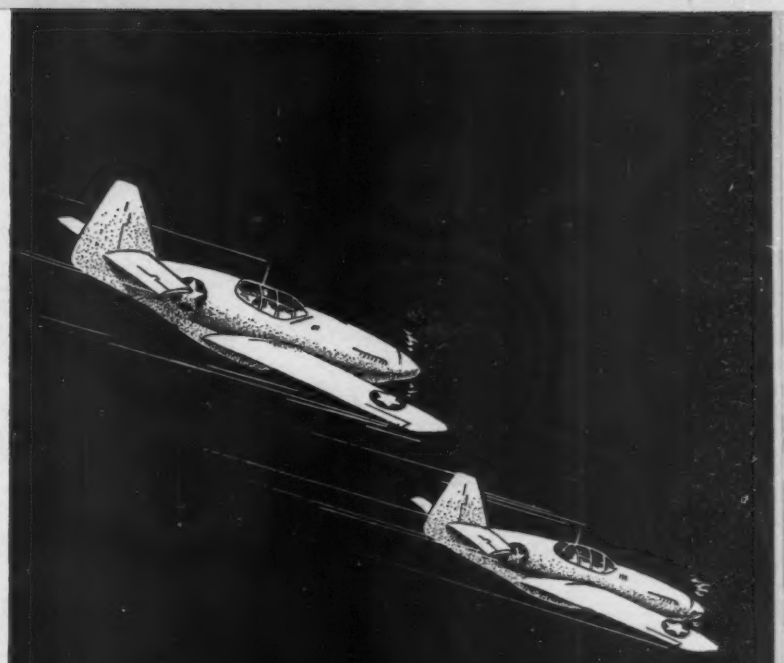
Among safety items being made available to employees by Cessna are unbreakable glasses ground according to prescription.

Life of generator brushes at altitudes above 30,000 ft. has been increased from about 2 to more than 300 hr. by a new treating method developed by Westinghouse. Wear on carbon brushes now being installed in 200-amp., 28½-v. generators has been calculated at .001 in. per hr.

Substitution of hot-finished for cold-drawn seamless steel tubing, previously brought to the attention of industry by WPB, is again recommended by the Seamless Steel Tube Institute for material of 3 in. outside diameter or greater. "Every foot of seamless tubing that can be made and shipped in the hot-finished condition," says the Institute, "represents an extra foot of tubing that can be cold-drawn for aircraft or other war equipment."

Jig boring of gear centers has been simplified for semi-skilled operators by means of a locating fixture developed by General Electric. When the fixture, a cubical steel block with a rack and pinion gear actuating a locating pin, is set and the master plate assembled to its parallels, the worker merely follows the holes in the plate.

Reductions in cost and alloy steel requirements and greatly increased production speed are said to result from new process of making blank and pierce dies developed by Algoma Products, Detroit. Dies are produced from templates of the parts themselves, eliminating need for special designs and simplifying engineering alterations.



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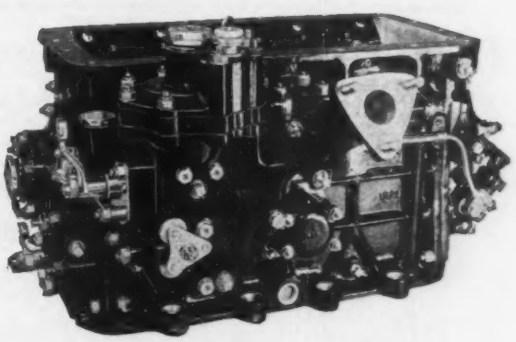
CARBURETOR

First TO REDUCE "SCOOP EFFECT"
TO A SATISFACTORY MINIMUM



Overcoming "scoopitis" has been a major engineering problem . . . special calibration for each installation, so long essential, is not required where Ceco carburetors are used . . . another Chandler-Evans "First".

Chandler-Evans Corp.
SOUTH MERIDEN, CONN.

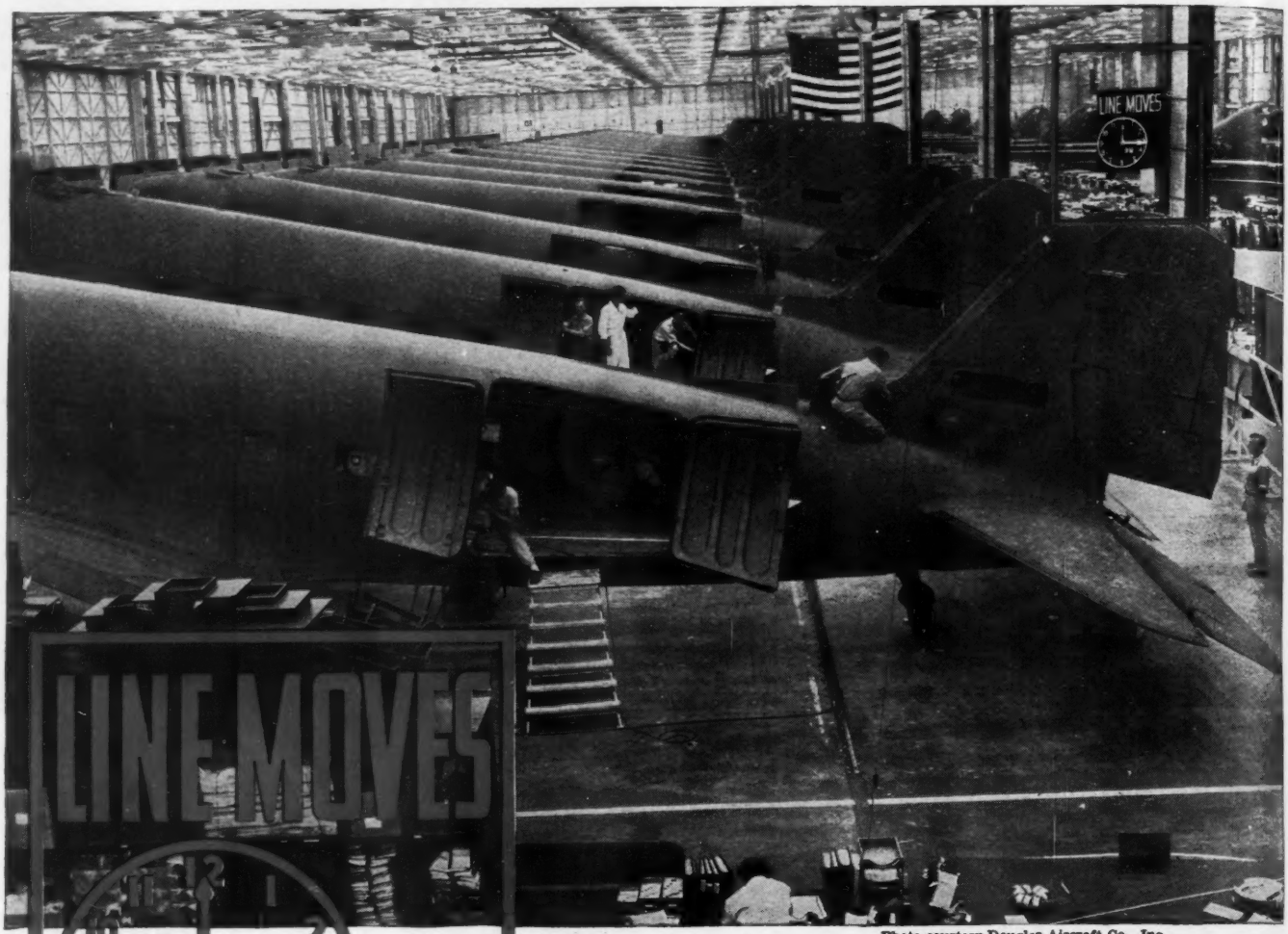
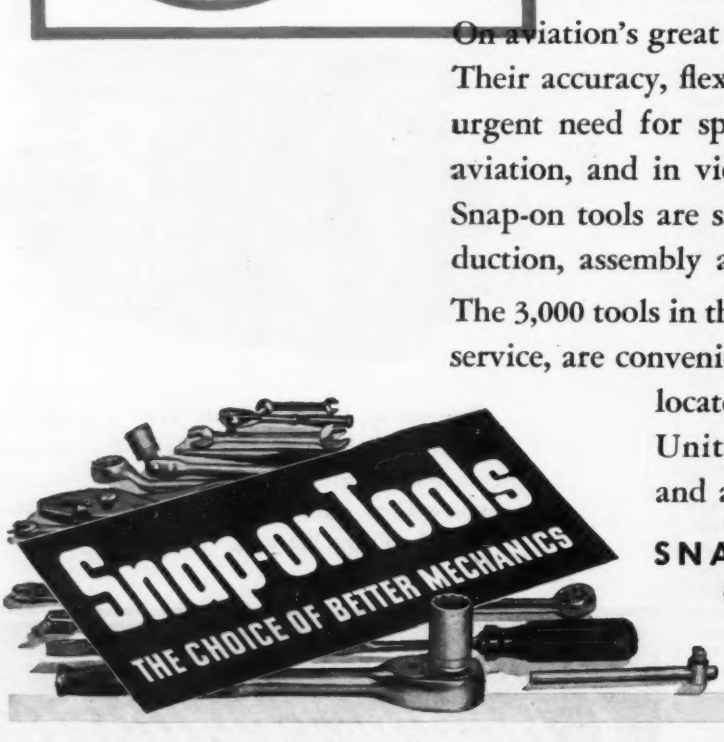


Photo courtesy Douglas Aircraft Co., Inc.

. . . and right down the line, every minute counts . . . every second counts . . . every deft swing of a wrench counts . . . to keep operations "on the clock" . . . to keep these huge Skytrains moving toward completion on schedule.

On aviation's great assembly lines Snap-on tools are on the job! Their accuracy, flexibility and quick application help meet the urgent need for speed, and more speed. In every branch of aviation, and in victory-geared industry throughout America, Snap-on tools are saving precious time in every phase of production, assembly and maintenance.

The 3,000 tools in the Snap-on line, and Snap-on's direct-to-user service, are conveniently available through 35 factory branches located at key production centers throughout the United States and Canada. Write for catalog and address of the nearest branch.



SNAP-ON TOOLS CORPORATION
8020-G 28th Avenue • Kenosha, Wisconsin

18 Lines Frown on Government Participation And Inter-Nation Controls; PAA Stand Differs

Washington (AVIATION Bureau)—Eighteen airlines have declared themselves unqualifiedly against government participation in the management or ownership of their companies and against any international air transport operation conducted in whole or in part through internationally owned and controlled government corporations. Past performance, they feel, is proof enough that private management is capable of handling postwar international transportation.

This stand was made public in a joint statement of the companies, not including Pan American, in answering a number of questions relating to postwar air commerce problems asked by the Civil Aeronautics Board.

Juan T. Trippe, president of PAA, advocates that British Overseas Airways Corp. and other United Nation's lines be permitted to obtain from the U. S. whatever transports they need to maintain international postwar competition. "If you want to win a baseball game," he puts it, "you try to out hit the other fellow, but you don't take away his bat. Friendship will result from fair play."

A similar list of questions was sent by CAB to the Senate Interstate Commerce Committee, the House Interstate, Foreign, and Domestic Commerce Committee, all aircraft manufacturers, all airline operators, all companies who have filed applications for certificates of operation with the Board, aviation societies, and men high in the industry. No other group has made its answers public, and CAB does not presently plan to release any summarizing report.

It is understood that the sub-committee of the government inter-departmental committee, comprising aviation experts who are studying the same problems, has declared against government ownership in any degree and against monopoly by any single U. S. airline. But the committee is said to favor giving many U. S. lines an opportunity to fly to foreign lands. These opinions are regarded of utmost importance since the committee is made up of representatives from the Departments of State, Commerce, War and Navy, CAB, Office of Emergency Management, and, recently added, the Board of Economic Warfare.

While the airlines desire to operate abroad, they realize that approval must come from government authorities. However, they urge that the government work out as soon as possible a reciprocal exchange with other countries of the general right of innocent flight (non-military) together with the right to land for refueling and for other technical purposes. This same view is emphasized by the inter-departmental committee, according to well-founded reports. Both airline and government officials are studying postwar proposals for the AAF Air Transport Command.

Helicopter Routes Filed

Applications for helicopter services have been filed with CAB by Skyway Corp., Providence, R. I., and Southwest Airways, Phoenix, Ariz.

Fifty-three cities in Connecticut, Massachusetts, New Hampshire, New York, and Rhode Island will be linked by the proposed Skyway routes, according to the company's application filed about a month after Northeast's request to serve 400 New England localities. Neither company owns any helicopters now.

Southwest Airways plan, primarily a mail and express service, calls for four daily landings, a total of 1,350 mi., on the roofs or near 46 post offices in the Los Angeles area.

Anniversary Observed With Record Mail Loads

As the 25th anniversary of airmail was celebrated in mid-May at the Washington National Airport and other flying centers, various lines were announcing new highs in carriage of mail passengers and express. To ease the mail strain, which has frequently caused sacks to be delayed or shipped by rail, the War Department subsequently released three used transports to mail carriers. CAB is working for further domestic assignment of "a substantial number of planes for the lines. Among companies reporting on recent operations were:

United Air Lines: While revenue plane miles decreased 21 percent but revenue passenger miles less than 1 percent during April compared to last year, airmail pound miles rose 95 percent and air express 40 percent, one-third of it originating or terminating at a connecting rail point. During May United made another six percent gain in revenue passenger miles over the same month last year, as revenue plane miles went down 15 percent.

Northwest Airlines: An April record of 7,080 revenue passengers, a gain of 1,208 over March, making a total of 21,719 since the year began. A new record was established for mail with a gain of 40 percent over April last year. Express pounds and miles nearly doubled.

American Airlines: Mail and express increased 91.1 and 124.7 percent respectively during April over last year. Load factor for revenue passengers has increased 9 percent during the year despite a decrease of 5,641,851 revenue passenger miles due to reduced equipment.

Continental Air Lines: A March total of 16,670,094 lb. mi. of mail, an increase of 3,681 percent over March, 1935, during the company's first year of operation.

Pan American Airways: Over 2,500,000 lb. of mail, an estimated 100,000,000 letters, in four years of trans-Atlantic flying. During the first quarter of this year, the company's passenger miles flown increased 57 percent over the same period in 1942. Plane miles were up 5,324,156.

Railway Express Agency: Rail-air shipments, 34.7 percent of total shipments during March, increased 49.6 percent over last year while all-air shipments went up only 2.3.

Mechanics' Wages Raised

With the approval of the National Railway Labor Panel, the Air Line Mechanics Assn. has obtained wage increases through collective bargaining from Chicago and Southern Air Lines within the 15 percent limit set by the Little Steel Formula. Up for acceptance by the railway panel are the association's agreements for wage raises by American Airlines, and time and a half beyond 40 hours in Northwest Airlines' modification centers.

International

ONE DAY OF YESTERYEAR

En route from Montreal to Washington in a Pitcairn "Mailwing," 220-hp. sister ship of the plane which made the first airmail flight to Canada, Capt. Herbert Clark, director of flight operations of Colonial Airlines, lands at LaGuardia Field for a sack of letters to add to the one of congratulation he carried from Prime Minister King to Pres. Roosevelt.

Kemp, Damon, and Davies Outline Various Types of Postwar Planes and Schedules

Probable shape of commercial transport services to develop in the United States during the next ten years or so has been considered by leaders of the industry in recent public speeches.

Following a conversion period of about two years, "we can expect to be flying ships seating 100 to 400 passengers at cruising speeds approaching 300 mph. with a trans-Atlantic fare of less than $100 at present price levels."

A. N. Kemp, president of American Airlines has told the National Industrial Conference Board. Mr. Kemp said that future "exact performance characteristics cannot be predicted but in the not distant future we can expect rates, both domestic and international, which will provide fares on planes cruising upward of 400 mph. This will permit fares of from $14 to $20 from New York to Chicago; from $55 to $75 to Los Angeles; from $75 to $120 to Europe; and $5 to $7 from New York to Washington."

Such developments, he warned, were contingent upon continuation of present, non-political Federal control. "I believe we can rely upon sound thinking in Washington," he said, "to see that the American form of free enterprise will maintain our place in the air world."

Mr. Kemp's prediction of 400 mph. transport speeds was echoed as probable within 10 years in a speech before the Society of Automotive Engineers by Ralph S. Damon, president of Republic Aviation Corp., who endorsed the proposal of CAB Chairman Welsh Pogue that nations have non-exclusive world flying rights.

Pointing out that "at no time has the engineer in aviation stood on greater thresholds of opportunity," Mr. Damon mentioned among possible developments the suppression of all protuberances, including "even the fuselage and tail itself" into a flying wing, rocket or squirt propulsion which may produce super-sonic speeds and attendant aerodynamic problems, increased glider pick-up and discharge systems, more powerful fuels, and assisted take-offs for planes with high wing loadings. He doubted that planes would displace more than one-tenth of shipments now carried by rail, road, and water but rather would "create new opportunities for trade and stimulate new desires for travel."

In a speech before the American Society of Mechanical Engineers, W. W. Davies, research engineer of United Air Lines, recommended four types of planes for possible postwar development.

They are a four-engined, 63½-ton, 100-passenger plane cruising at 266 mph. and having a range of 2,500 mi.; a four-engine, 40-ton moderate range plane for "club" service, a twin-engine 21-ton variable load carrier for either passengers or cargo; and a twin-engine, 16-ton freight plane.

Mr. Davies anticipates an 11½-hr. trip coast-to-coast with one or two stops, larger airports with complete instrument landing facilities, decreased fuel consumption, higher altitudes by use of superchargers, development of diesel engines, increased propeller efficiency, and a better ratio of useful load to gross weight. He visualizes parallel runways 8,000 to 10,000 ft. long on large terminals and 6,000 to 8,000 ft. on medium terminals, feeder terminals with runways 5,000 to 6,000 ft. and strip runways of 8,000 to 10,000 feet.

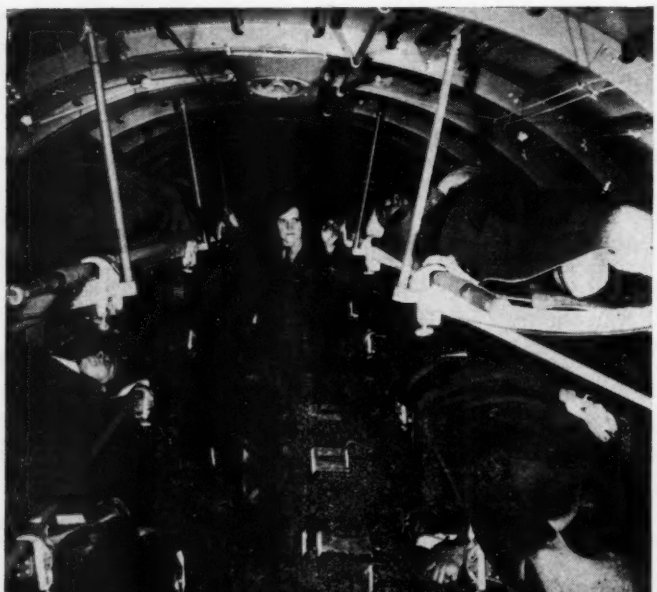
Feeder Routes Granted But War Delays Operation

Washington (AVIATION Bureau)—The Civil Aeronautics Board recently announced decisions on several pending applications for additional air service.

TWA was granted authorization to serve both Los Angeles and San Francisco on flights originating in Albuquerque, N. M., and points east, by amendment of its route No. 37 including Los Angeles as an intermediate point between Las Vegas and Fresno. United is the only airline authorized to operate between San Francisco and Los Angeles.

Western was permitted to include San Bernardino, Calif., as an intermediate point between San Diego and Long Beach. United was granted permission to include Stockton, Modesto, Merced, and Visalia, Calif., as additional local points on its route between San Francisco and Los Angeles. Operation of the new routes will not begin until war conditions permit.

Decision on the "Texas Case," involving the applications of four lines for additional routes in Texas, New Mexico, and Colorado, have also been announced by CAB. The Board extended the route operated by Braniff Airways from Amarillo, to Denver, via Pueblo and Colorado Springs. The extension, effective when conditions permit, provides that Pueblo and Colorado Springs, on the route of Continental, be served only by flights originating and terminating at Fort Worth-Dallas or points south.



Click Photo

FLYING WARD

Three tiers of litters, which can be stowed when troops are carried, are rigged by bars and brackets to the ceiling and walls of this Douglas C-47 "Skytrain" when bringing wounded back to hospitals. OWI reports that as many as 30 casualties can be carried in the largest planes and that "a number of serious cases recently reached Washington from India in five days—a distance of 10,000 mi."

6 Planes—17 Lines

When the War Department announced that six cargo planes would be released to the airlines within 60 days, CAB was faced with the problem of allotting them among 17 anxious and under-equipped operators. It was decided that they would be assigned three at a time, the first lot going to small companies with the largest backlog of passenger traffic. Some lines are already reduced to one or two planes.

The release comes as the result of CAB's pleading for additional equipment. Last year 158 planes out of 324 operated by commercial lines before Pearl Harbor were commandeered by the War Department, leaving 166, nearly all DC-3's.

Although CAB denied Braniff's request for a permanent certificate between San Antonio and El Paso via Uvalde, Del Rio, and Marfa, it indicated that such a service would be authorized on a temporary basis to determine the traffic needs if an application were filed. In a separate statement, Chairman Pogue and Member Lee expressed the opinion that Braniff's application for this route should be approved now and that the authority should be granted permanently.

Safety Awards Given

On the basis of official CAA records, the National Safety Council has presented safety awards to three airlines and cited others for operations during 1942.

Classifying lines into three groups—over 100 million mi., 10 to 100 million mi. and less than 10 million mi.—the Council announced the respective winners as Eastern Air Lines, Braniff Airways, and Mid-Continent Airlines.

Other carriers also cited for no fatalities during the year were Chicago & Southern, Delta Air Corp., Pennsylvania-Central, Catalina Air Transport, Continental, Inland, National and Northeast.

ATA Elects Officers

Croil Hunter, president of Northwest Airlines, has been elected vice-president of the Air Transport Assn., and M. F. Redfern and Joseph Hintersehr have been chosen secretary and treasurer respectively, positions held since ATA's founding in 1936 by Fowler Barker, who has resigned to become editor of McGraw-Hill's forthcoming

Air Transport magazine. Col. Edgar S. Gorrell continues as ATA president.

Elected directors of the association at its eighth annual meeting in New York last month were W. A. Patterson, United Air Lines; T. E. Braniff, Braniff Airways; O. M. Mosier, American Airlines; Terrell C. Drinkwater, Continental Air Lines; Jack Frye, TWA; C. Bedell Monro, Penn-Central; and E. V. Rickenbacker, Eastern.

NWA Forms Committee On Postwar Operations

Establishment of a committee "to study problems in connection with the conversion of company operations from wartime to peacetime economy" has been approved by Northwest Airlines' board of directors. Croil Hunter, president and general manager, is about to announce names of members chosen from company executive personnel and outside engineering, traffic, maintenance, and operations authorities who will participate in conferences on future plans.

Since the start of the war total personnel has expanded from 800 to between 8,000 and 9,000, and the company has asked permission to extend its services from Chicago to Washington and New York and has filed applications for routes to Alaska, the Philippines, China, and India. "Expansion of commercial operation through the granting of new routes undoubtedly will absorb part of the present organization," Mr. Hunter said, "and it is hoped that the Civil Aeronautics Board will take immediate action to consider favorably all our pending applications for new routes."

Harris & Ewing

ADAPTABLE BEANSTALK

For loading through cargo doors of various heights without ramps, the Army Transport Command is using these adjustable lift trucks. Here a radial engine goes aboard a C-46 "Commando."

OWI Says Ingenuity Makes Up for Lack Of Design in Transports Used in War

Pointing out that "not a single plane originally conceived solely to carry cargo is in service in the Western Hemisphere at the present time, although several are in the process of design and manufacture," a report on air transport issued by the OWI asserts that "at present American air transport needs are being filled by operations that show considerable ingenuity but which cannot be called efficient from any modern requirement of cargo-carrying economies."

"Planes originally designed for passenger transportation, even the newest models such as the C-54 and the C-46, are still far from ideal for the cargo-carrying work which they are performing so faithfully," says OWI. "This country is fortunate in having had such a high development of airline planes and operations at the beginning of the war."

While private flying is now nonexistent and the commercial fleet has been cut practically in half "the airlines are carrying only slightly fewer passengers than were carried by the whole fleet before the war and more mail and express." Equally impressive records, the report says, are being made by the Air Transport Command, which is now operating over more than 90,000 mi., establishing in some places the first regular, scheduled service.

The number of planes operated by ATC is secret, but the principal types are listed as C-53, C-47, C-46, C-54, C-87, C-60, C-49, and C-48. With this equipment "to points within the Western Hemisphere alone the ATC is flying more than 1,000,000 lb. of cargo each week, and if the war continues into 1944," OWI estimates that "its routes will probably be ten times as long as the combined routes of all the world's prewar airlines. . . . Losses have never risen above one percent." The Naval Air Transport Service is operating more than 50,000 route miles with planes including the DC-3, *Coronado, Mariner,* DC-4, *Lodestar* and others under its designations.

Contained in a seven-page appendix to the report are data and performance figures on various transports including the Kaiser-Hughes flying boat and the Lockheed C-69 *Constellation,* designed as a long-range passenger transport with a pressurized cabin for altitudes above 20,000. The C-69, largest land transport yet built with wingspread of 123 ft., "at full power at altitudes up to 30,000 and 35,000 ft. is designed to carry 55 passengers at a higher speed than is reached by a Jap Zero." The plane has four 2,000-hp. Wright R-3350 engines, standard gross weight of 73,500 lb. (empty approximately 45,000 lb.), fuel capacity of 4,800 gal. and an "average cruising speed of 225 mph, at sea level, increasing to 300 mph. at 19,000 ft."

Describing progress on the Kaiser - Hughes plane, OWI calls it "a giant, all-plywood ship, 400,000 lb. gross weight, being built primarily for cargo carrying. Static testing of some sections has begun. Eight engines, 8,000 gal. fuel capacity, 120,000 lb. cargo capacity. Average cruising speed 174 mph. By far the largest aircraft actually under construction, with a 320-ft. wing spread and a 218-ft. length, the HK-1 is being built under contract to the Defense Plant Corp."

[Subsequently Kaiser representatives reported that a 16 ft. long scale model had completed tests satisfactory to the WPB.]

Government and ATA Consider Insurance Plans

Washington (AVIATION Bureau)—Some time this fall Congress will consider a bill by Rep. Clarence Lea which provides for government air insurance and re-insurance against loss due to war and for re-insurance against ordinary air risks. The proposed law will apply to both fixed base and scheduled transport operations.

Sponsors of the bill say that re-insurance business now centers in England, that only a few U. S. companies, whose policies are controlled from London, are in a position to serve American aviation, that small companies cannot get into the business here, and that resulting high rates to domestic air operators eventually are charged up as part of the cost of carrying the mail.

The bill aims to prepare for heavy risks that will attend the big transocean planes and valuable cargoes expected after the war. Heavier liability and crash risks will call for far greater spreading of risks and pooling of reserves than are feasible now. While the Civil Aeronautics Board would be authorized to write insurance and re-insurance, it probably would not actually do so. Enactment of the bill, it is expected, would bring the stock and mutual companies into a friendly co-operation which would give them enough backing to write re-insurance at home, instead of letting it be financed abroad.

There is some opposition to the proposal from individual transport operators, who want to make sure that insurance will not lead to additional government control of airlines. But there is no organized resistance to Lea's bill. CAB is expected to complete a report on it this month, but Congress will probably not act till September or later.

The Air Transport Assn. is understood to be writing a report on the bill also and is advocating that line officials appoint a committee to put another insurance plan in operation by the early part of 1944.

This "airline company plan" advocates handling insurance through two stock insurance companies with capital and surplus of $3,000,000, 60 percent of which would be furnished by the companies and 40 percent by the lines. One company, with capital of $1,250,000 and surplus of $750,000, would write various types of casualty insurance. The other, with capital of $625,000 and surplus of $375,000, would handle fire policies. Insurance companies would furnish $1,800,000, the airlines $1,200,000.

★ CROSS COUNTRY ★

With resumption of operations in and out of San Diego under CAB authorization, United Air Lines has added a stop at Eugene, Ore., sixteenth city on its Pacific Coast route . . . Union Airways has been incorporated by Edward N. and George N. Oswald and J. Henry Reisner, formerly of Krieder-Reisner Aircraft Co., to establish feeder routes to major lines operating in the vicinity of Hagerstown, Md. . . . During four years' trans-Atlantic service, Pan American reports that its *Clippers* have flown more than 6,862,000 miles in 1,400 crossings, carrying over 44,000 passengers. Since the beginning of the war 1,700 tons of express have gone over.

Aviation Abroad

British Airway Group Urges Deal with U. S.

A Joint Air Transport Committee has been formed in England with strong backing to urge a conclusive agreement with the United States on apportionment of postwar airways among the nations. Oliver Simmonds, British plane producer, has been in this country for several weeks, partly in the interest of the group.

The British had expressed concern over what they termed possible "American dominance" of postwar services. The British Chamber of Commerce, the Federation of British Industries, and the London Chamber of Commerce, now represented by a committee, urge formation of a huge international syndicate in which all the United Nations would have a share in postwar passenger traffic.

The Joint Air Transport Committee urges that Britain "put in hand forthwith" new and modern transport planes, initially of U. S. manufacture, for the British Air Transport Command and that Britain begin the production now of its own transports, which it can do without detriment to its air war, according to the committee.

Rather than implying that the U. S. is planning to make off with the postwar transport show, the committee takes the position that it will be necessary for America to supply most all of the urgently needed world services unless the British get set to pull their part of the freight. It is suggested that the U. S. and Britain negotiate a mutually acceptable parity yardstick for the division of international services, both countries reserving the right to operate routes without hindrance between territories under their respective flags.

Once a preliminary agreement has been reached, discussions would follow with Russia and China and other United Nations. No mention is made of allowing any rights to the defeated Axis countries.

Russian Assembly Lines Adopt Conveyor Methods

For the first time in Russian aircraft production, Soviet plants are using the new assembly line methods, following a recent double-quick reorganization.

The transformation, which took two to three weeks in most plants, with little loss of output, is reported by reliable Moscow sources, to have reduced defective material and the time necessary to train new workers. The conveyor belt systems are modeled on American types, one technical expert reported. Another expert said, "We have done this without any outside help, on a large scale, and with great success."

In one factory, which was converted in 16 days, efficiency per worker is reported to have increased 41 percent, the number of auxiliary workers has been reduced 500 percent, and production has been doubled. Time on fuselages was reduced from 160 to 62 hr.

INTERNATIONAL BRIEFS

As British Overseas Airways Corp. celebrated its third birthday with the announcement that it has been flying better than a million miles a month since Jan., 1942, Viscount Knollys resigned as governor of Bermuda to become chairman of the line's board of directors. Opposition to his appointment is expected.

First quarter figures issued by PAA indicate a nearly 100 percent increase in passengers, freight, and mail over 1942. Inter-American aircraft flown by the company now cover approximately 1,000,000 mi. per month. Daily service between Miami and Cayenne, French Guiana, was recently added to the list of regular stops of all landplanes operating on PAA's route from Miami to Buenos Aires.

Two new types of planes have been added to the American Export Airlines fleet, the Martin PBM-3 commercial version and the Consolidated *Coronado* PB2Y3. To accommodate this increased number of aircraft, the line's facilities at La Guardia Field will be trebled.

The British sent 40 planes—mostly heavy bombers—over Reichland during May for every German plane that scurried across English skies. "Compared with this time last year," Mr. Churchill told the House of Commons, "we can now drop more than double the weight of bombs at the 1,500-mi. range, there and back."

Air Chief Marshal Sir Hugh C. T. Dowding, who directed the RAF during the Battle of Britain, was made a Baron in the King's recent birthday honors list. Other airmen mentioned were Ernest Walter Hives, leader in the development of British plane engines, Roy A. Chadwick, designer of the *Lancaster* bomber, and W. S. Farren, associate of Lord Beaverbrook.

The 10th U. S. Air Force, reports Correspondent Herbert L. Matthews to the New York *Times*, has been giving the Japs in Burma "a pasting that ranks with the London blitz of 1940. American medium bombers—B-25's—did 40 days' bombing without a break." Unfortunately, the rainy season has now stopped operations for about four months.

Growth of Russian airpower is indicated by several figures. During the first week in June, Soviet airmen, said an official communique, destroyed 752 Nazi planes with a loss of but 212. And Moscow puts German May losses at 2,069. On at least one recent occasion, the Russians have employed 520 planes in their mass raids against German positions.

The Germans are planning erection of factories and hydroelectric plants to turn Croatian bauxite into aluminum. It is said one plant would have a capacity of 100,000 tons.

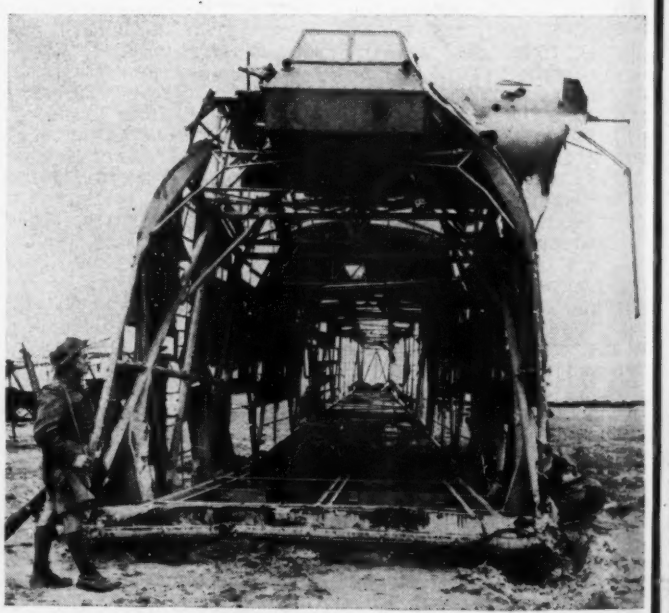
A new Swedish twin-engine bomber, the B-18, has been announced along with the J-22, reportedly the fastest plane in the world for its limited-engine power class.

One report has it that the Italians have been making nuisance raids to Eritrea in practice for possible attacks against North America. But the recent news from the Mediterranean indicates that Mussolini's flyers now have more vital matters to think about right at home.

Germans Had Seadrome

That seadrome proposal, recently publicized by Penn Central Airlines, calls attention to the fact that an ocean landing field was constructed some ten years ago in Germany and used in a popular film, *FP-1 Does Not Answer*. This seadrome floated in the Baltic for about two years, where it was towed from spot to spot by an old freighter. The flight deck was about 650 ft. long and was successfully used by single-engine Junkers planes during the shooting of the film.

It rode out many a storm and while not anchored at the great depths proposed for the ocean type, it proved to be steady and reliable in most kinds of weather.



International News Service

OPEN FOR INSPECTION

This is the skeleton fuselage of one of Hitler's six-engine Me-323 "power gliders," wrecked by Nazis retreating in Tunisia. Revealed are many details of the welded tubular construction of the unique flying boxcar.

Mexican Routes Double

During the last eleven months, the total length of civil aviation routes in Mexico has more than doubled, Gen. Alberto Salinas Carranza, chief of the Department of Civil Aeronautics, announced during a recent visit to Washington.

This expansion, resulting largely from wartime curtailment of water traffic, has been accomplished, the general said, through better maintenance and with no increase in equipment. Chicle, mineral concentrates, and coffee are the chief articles carried by the Mexican flyers, many of them trained in this country. Fewer delays, it has been found, make it economical to fly coffee.

Canadian Notes

By James Montagnes

A large number of Canadian aviation men other than those in the Royal Canadian Air Force were honored in the King's birthday list. Highest award was that of Officer in the Order of the British Empire which was given to five civilians: Ralph P. Bell, Halifax, director-general of aircraft production, Department of Munitions and Supply; Ray Lawson, Montreal, chairman of the board, Federal Aircraft, Ltd., government wartime aircraft company; Leslie J. Martin, Vancouver, manager of civilian flying training schools; Cecil W. Nicholl, Winnipeg, for valuable public service in connection with organization of civilian flying training schools; and Murton A. Seymour, St. Catherines, Ont., president of the Canadian Flying Clubs Assn.

Made Member of the Order of the British Empire were Ross Duff Butterill, Dunnville, Ont., civilian meteorological officer of the British Commonwealth Air Training Plan; Carlyle Gerow, Ottawa, director of supply administration, Department of National Defense for Air; Byron I. Johnson, New Westminster, B. C., technical adviser, British Commonwealth Air Training Plan; J. A. D. McCurdy, Ottawa, superintendent of aircraft purchasing division, Department of Munitions and Supply (McCurdy, incidentally, was the first man in the British Empire to fly, taking off at Baddeck, N. S., on Feb. 23, 1909); P. D. McTaggart-Cowan, Montreal, for work in connection with air transport under the Department of Transport; and W. A. Newman, Montreal, president Federal Aircraft, Ltd.

Trans-Canada Air Lines, government-owned transport operator, has been given permission by the Board of Transport Commissioners to extend its transcontinental service from Vancouver to Victoria, B. C., but it was restricted from operating a local service between the two cities in competition with Canadian Airways, a subsidiary of Canadian Pacific Airlines.

This is an important ruling in view of Prime Minister King's recent statement that no competitive routes would be allowed, either between privately or publicly-owned systems. It is also of interest in view of applications of United States airlines for through service to, and beyond, Canada in postwar years.

The commissioners ruled that the rights of airlines now operating local services cannot be wiped out whenever the government-owned concern wishes to establish mainline service and that TCA is in the same position as any ordinary competitive carrier when it comes before the board. It was maintained that to grant TCA a local service license would eventually drive Canadian airways out of business, since it did not seem that both companies could continue to operate profitably. TCA, it is stated, carried 11,537 passengers during April, 2,722 more than during the same month last year. Mail more than doubled —from 139,379 to 292,401 lb. —and express multiplied from 16,572 to 61,577 lb.

Some interesting facts and figures were recently given Parliament by C. G. Power, Minister of Air. He stated that the total costs of the 1943-44 fiscal year for the RCAF would be over $1,100,000,000 compared to last year's $603,000,000. There are now 191,500 in the RCAF, including 11,390 in the Women's Division, after deducting discharges and casualties. About 50,000 aircrews have been trained and 40,000 personnel sent overseas. The average daily flight-miles in training amount to over 2,000,000, while more than 6,500,000,000 miles have been flown since the RCAF training started. Casualties in Canada have been 1,367, overseas 5,683.

On Schedule . . . by "Vista"

For the first time since the route was flown under complete wartime conditions, a plane of the London-Lisbon line was attacked by German fighters around Apr. 19, but due to evasive action it escaped serious damage. A few weeks later, however, one of the BOAC's aircraft, a DC-3 chartered from KLM and flown by a Dutch crew, was shot down over the Bay of Biscay with the apparent loss of 14 persons. Indications are that this attack was made solely in an attempt to get at the plane carrying the British Prime Minister back to London, since in the past years Axis fighters, though sighting Lisbon-route transports, have not attacked them. It had been felt that there was an unspoken mutual agreement between the belligerents to leave commercial transports alone, but apparently this truce has been broken. British long-range fighters may now reply by attacking Axis commercial transports.

Many striking and some wild, applications have been made to the CAB for new routes, running from domestic helicopter services to broad networks over the world. At any rate, certain of the postwar plans now before the Board will require very close study to determine their true economic possibilities. The decisions are awaited with deep interest.

One application received by the CAB (from Chicago & Southern) requests permission for a Chicago-Alaska-Siberia-China-Singapore-Batavia route. There is little doubt in most peoples' minds that traffic to the Far East will get a tremendous boost after the war. This specific route is approximately 10,000 mi. long, which is some 3,500 mi. less than the prewar run from Europe via either BOAC's or KLM's Far Eastern routes to Singapore, the East Indies, and Australia. And remembering PAA's trans-Pacific performances, a San Francisco-Hawaii-Darwin, Australia, route can be envisioned totaling in the neighborhood of 8,000 mi.

Five airlines have received permits to supplement trans-Caribbean services of present carriers for a period not to exceed the war by more than six months. The carriers are: British West Indian Airways (Trinidad to Miami); KLM (Curacao to Miami); TACA (San Jose to Miami); C. N. Cubana de aviacion (Havana to Miami); and Expreso Aereo Inter-Americano (Havana to Miami). The Board's decision means at least temporary abandonment of the so-called monopoly policy in the Caribbean area. The competitive performances should subsequently show whether the plan will be destructive, as some quarters claim, or whether it will "work" and bring about better service to the flying public.

Douhet Disowned?

In an infinitesimal effort to bolster morale, one Italian newspaper, *Regime Fascista*, has declared that the documents of the late Italian Gen. Giulio Douhet, pioneer exponent of air power have been kept hidden in archives and that his theories "were never put into effect by Italy."

Giving the lie to this assertion, Douhet's translator, Dino Ferrari, quotes Douhet in a letter to the New York *Times*: "The cardinal points of the program for national defense which I proposed," said the general, "have been accepted and incorporated into the organization of the armed forces of the nation."

RCAF Photo

MOBILE CONTROL TOWER

To expedite runway control at training stations, the Royal Canadian Air Force has developed this mobile control tower, which is in constant radio contact with the regular tower and can signal planes by radio or lights and flares.

Aviation Finance

Brewster Aeronautical Corp. is negotiating an increase from $35,000,000 to $50,000,000 in its regulation V loan, it is understood in banking circles. The company had a backlog of $275,000,000 when the present Kaiser management took over four months ago. Several new contracts have been reported since then and schedules are being fully met.

Ryan Aeronautical Co. reports an increase of 25 percent in gross revenues for the four months ended Feb. 28, according to Pres. T. Claude Ryan. Gross amounted to $7,430,258 while net totaled $287,047 or around 65c. a share after all charges except renegotiation.

United Aircraft Corp. shipments in the first quarter totalled $159,169,553 while net profit was $4,050,749 or $1.40 a common share.

Irving Air Chute earned a net profit of $316,835 or $1.60 a share in 1942, against $371,537 or $1.88 a share in 1941.

Mid-Continent Airlines, which flies routes in Nebraska and Kansas, has been mentioned several times in merger rumors during the last few months. But so far, according to a Wall Street report, nothing definite has developed.

Bendix Aviation Corp. reports net earnings of $8,190,449 or $3.87 a share for the six months ended Mar. 31, against $8,122,679 or $3.84 a share in the like 1942 period. Net sales were $417,812,579, an increase of 145 percent from the previous year, according to Pres. E. R. Breech. Unfilled orders stood at more than $1,000,000,000. Voluntary price reductions since Sept. 1941 have totaled more than $200,000,000.

Jacobs Aircraft Engine Co. has received an additional Defense Plant contract for $625,000, making its total commitment for additional facilities approximately $22,000,000. American Export Airlines now has total commitments with DPC for $1,100,000.

Thompson Products, Inc. earned $448,952 or $1.41 a share in the first quarter against $130,785 or 83c. a share in the like 1942 period. Sales were $30,112,251 compared with $13,913,150 a year ago.

American Export Lines, which owns 56,000 shares of the 80,000 shares of American Export Airlines, Inc., has been ordered to submit a plan to the CAB divesting itself of control of its airline affiliate within nine months.

Square D Co. reports net earnings of $679,203 or $1.56 a share on the common stock for the March quarter compared with $1,019,107 or $2.36 a share in the like 1942 period.

Lockheed Aircraft Corp. has taken a major step in postwar planning through the purchase, for $3,750,000, of controlling interest in Pacific Finance Corp. for the purpose of financing private plane sales when the war ends. The majority interest in the automobile financing concern was acquired through purchase of stock owned by Transamerica and associated interests. Pres. Robert E. Gross, and four other Lockheed directors have been appointed to the directorate of Pacific Finance. The finance company has sales offices in a number of Pacific Coast and Southwestern states.

Northwest Airlines' directors have approved a plan calling for a postwar planning committee to study problems of conversion to a peacetime economy. Members of the group will consist of officials of the line and advisory authorities from the outside, according to Pres. Croil Hunter.

Douglas Aircraft Co. has negotiated a revolving credit totaling $40,000,000 with a nationwide group of banks. The credit runs for one year with the privilege of requesting an extension each 90 days up to a maximum of two years.

McDonnell Aircraft Corp., St. Louis, also has signed a contract with nine banks for a regulation V loan of $6,000,000. This loan will run until Dec. 31, 1945, or until date of final government on the company's last war contract, whichever is earlier.

Glenn L. Martin Co.'s sales deliveries in the first four months of 1943 were double the $69,000,000 production in the entire 1941 year. Output was also larger than in the first eight months of 1942. At the same time, Vice-Pres. H. M. Horner of United Aircraft Corp. states that the Pratt & Whitney engine division will be called upon a year hence to produce, alone, as many engines as are now being turned out by Pratt & Whitney and its several licensees together.

Dividends: Bell Aircraft declared a dividend of $1 a share on the common stock payable June 25. Previous payment was last November when $2 was disbursed, the only payment in 1942 . . . United Aircraft Corp. paid a dividend of $1.50 a common share on June 15. Payments in 1942 were $1 in June and $2 in December . . . Glenn L. Martin Co. paid $1.50 a share on June 11, the same amount as disbursed in the only 1942 payment, made last December . . . Solar Aircraft paid 10c. a common share June 15, while Bendix Aviation Corp. and Continental Motors Corp. made the usual June quarterly payments of 15c. and 75c. a share, respectively. Holders of the old $10 par Continental Motors common stock are required to exchange their certificates for the present $1 par value stock before receiving this dividend.

Aeronca Aircraft Corp. reports 1942 sales of $3,263,758, not including deliveries on cost-plus-fixed-fee contracts, while net earnings after deduction of $333,147 for income taxes were $165,620. Output consisted of liaison and training planes, gliders, and a secret Air Corps weapon, according to Pres. Carl Friedlander.

American Airlines earned $584,772 or 92c. a common share in the March quarter compared with $349,392 or 51c. in the like 1942 period. Apparently the line expects to pay an excess profits tax this year, since tax reserves for the initial quarter of 1943 advanced to $1,375,000 from only $198,000 in the similar 1942 quarter.

Packer, Simpson & Gladeck have become associated with, and are substantial stockholders of, Langley Aviation Corp.

By RAYMOND L. HOADLEY

Renegotiation still a headache . . . Airlines gain . . . Government releases transports . . . "Stand-by" credit

A NUMBER of aircraft manufacturing companies still had not completed contract renegotiation on 1942 earnings by June 1. In fact, one of the largest companies in the industry had not even issued its 1942 report to stockholders because the renegotiation matter had not been settled. Most of the others, in their annual reports, had informed shareholders of differences amounting to millions of dollars between their renegotiation offers and the amounts the government boards sought from them.

No wonder the president of the New York Stock Exchange has requested aircraft companies to advise their stockholders of the results when renegotiation is finally concluded.

The months that have been consumed in renegotiating contracts in this one industry is indication enough that something is radically wrong with the renegotiation procedure. The position of the industry, in balking at the huge sums the government boards want returned, continues to be that the loss of these funds will weaken their postwar ability to provide employment and keep their industry strong for its tough job of reconversion to peacetime operations.

First-quarter earnings statements of the airlines show wide gains in profits from a year ago, but it might be well to caution the stockholder that the summer and fall quarters will give a truer measure of earning power than the March quarter. In the first place it is becoming quite obvious that airline profits have increased so substantially that this group is bound to be affected by the excess profits tax this year. Also it is likely that there will be an airline passenger fare cut of around 10 percent which, by way of example, would reduce one specific company's revenues by about $800,000. On the other hand the government has just released a few transport planes to some of the lines, and if more are spared in the course of the next six months, the addition of these extra planes could add appreciably to an airline's earning power.

Many of the aircraft manufacturing companies have arranged for large lines of stany-by credit from the banks, but few have made extensive use of the credit they now have at their beck and call. Now that the end of the "capital goods" phase of the war program is approaching and companies are receiving steady payments on their big deliveries, there isn't as much need for borrowed funds as formerly. But the nice thing about a stand-by credit is that it will be available when the war is over and funds are needed, while big inventories and receivables are temporarily tied up in war contract termination and liquidation.

headed by Vincent Bendix. Both organizations have been active in research and development work on molded plywood ships.

United Air Lines reports net earnings for the March quarter of $982,779 or 65c. a share compared with $143,002 or 9c. a share in the like 1942 period. Federal income taxes were estimated at $982,000 against $64,000 in the corresponding 1942 quarter. Pres. W. A. Patterson estimates that the proposed passenger fare changes will result in reduction of passenger revenues of from $750,000 to $800,000 during the second half of the year.

Here And There: Pres. Magin of the Square D Co. expects 1943 output of the Kollsman division to be materially greater this year than in 1942. . . . National Aviation reported net assets of $17.54 a share on March 31 compared with $13.75 the previous year. . . .

Liberty Aircraft Products has paid the $450,000 remainder of its loan on Auto Car Co. stock. . . . Boeing Airplane is negotiating with the government for acquisition of plant and equipment at the Seattle main factory, amounting to $7,769,000. These facilities would provide the company with an integrated plant for future operations. . . . Grumman stockholders have approved a pension plan for employees. . . . Robert V. Fleming and Harold White of White, Weld & Co., New York brokers, have been elected directors of Pennsylvania - Central Airlines. . . . Pres. T. C. Ryan, Ryan Aeronautical Co., has purchased 2,000 shares of his company's stock.

On the Raw Materials Front

Re 100-Octane—One-half of the aviation gasoline plants that will ultimately be needed in the war effort have been completed. All told, 45 plants producing 100-octane (or better) gasoline are in operation, while twice this number, according to military officials, will be needed to meet the ever-growing needs of our rapidly expanding air services and those of our allies. As matters stand now, production of high-octane gasoline is not meeting total requirements and it will be a number of months before the production curve crosses the requirements curve. In the meantime, no strategic bombings have been held back because of the shortage. But there has been a considerable reduction in the training program, with training craft idle on the ground when they could otherwise be in the air.

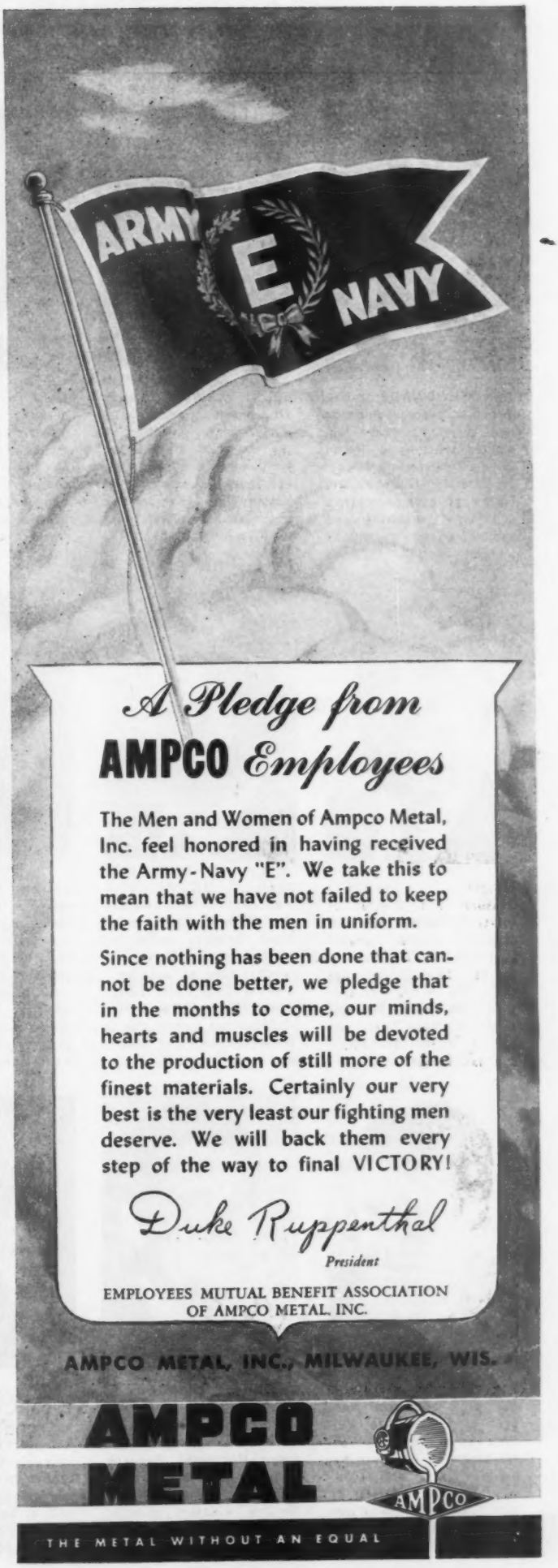
When the President called for 50,000 planes back in May 1940, the 100-octane refining capacity then in existence, or under construction, in this country was considered ample by the government despite warnings by some defense agency officials that output should be further expanded and reserves accumulated. Then in 1941 the arrival of the British Petroleum Mission emphasized that the United States was expected to supply much of the Allied needs as well as take care of our own requirements. The huge lend-lease shipments to Great Britain and Russia began. High-octane capacity in the fall of 1941 amounted to around 40,000 bbl. a day, and the expansion program at that time contemplated increases to 80,000 bbl. a day in 1942 and 120,000 bbl. daily in 1943.

Production figures have, of course, been secret since Pearl Harbor, but they are several times what government officials thought would be the nation's maximum war requirements back in 1940 and are now "far beyond what anyone believed even remotely possible" in 1941. It is not strange, though, that aviation gasoline war needs were grossly under-estimated in the early days of the conflict. No one could know then that every day Maj. Gen. Jimmy Doolittle and his men go up over the Mediterranean their planes consume an average of 1,100,000 gal. of gasoline.

In the 15 days that Gen. Doolittle and his 12th Air Force Command fought in the skies above Tunisia, their planes used up enough gasoline to empty every tank in the northeast coastal shortage area and keep them empty for a month.

It is fortunate indeed that the famous Washington priorities battle of octane gasoline versus synthetic rubber plant facilities has been straightened out, apparently to the satisfaction of all concerned. Acrimony has given way to cooperation, and so War Department officials are much more optimistic today than they were three months ago regarding progress of the aviation fuel program. Like most of the other real emergency programs, the aviation fuel project is coming out of the construction stage and getting well into production.

But the enemy will continue to establish the requirements—and so far warplane losses have been less than anticipated, with the result that there are more planes to fuel than the authorities had dared hope would be the case.


ARMY
E
NAVY
A Pledge from
AMPCO Employees
The Men and Women of Ampco Metal, Inc. feel honored in having received the Army-Navy "E". We take this to mean that we have not failed to keep the faith with the men in uniform.
Since nothing has been done that cannot be done better, we pledge that in the months to come, our minds, hearts and muscles will be devoted to the production of still more of the finest materials. Certainly our very best is the very least our fighting men deserve. We will back them every step of the way to final VICTORY!
Duke Ruppenthal
President
EMPLOYEES MUTUAL BENEFIT ASSOCIATION OF AMPCO METAL, INC.
AMPCO METAL, INC., MILWAUKEE, WIS.
AMPCO METAL
AMPCO
THE METAL WITHOUT AN EQUAL

Aviation People

BEN O. HOWARD, racing airman and engineering test pilot, has been appointed assistant to Donald Douglas, president of Douglas Aircraft. His work will pertain to technical matters and flight problems and special assignments will be included as well.

Harris & Ewing Photo

COL. HARRISON BRAND, JR., was unanimously elected general manager of the Aeronautical Chamber of Commerce of America. For several years prior to joining the Chamber he was executive secretary of the Washington Board of Trade.

CARL A. FRISCHE has been named chief research director of Sperry Gyroscope. In his new post, Mr. Frische assumes full charge of the company's Long Island laboratory. He has had complete charge of research engineering for the past year.

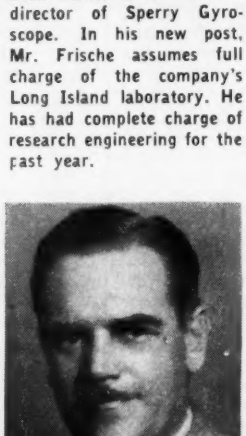
MAJ. CARL A. COVER left Douglas Aircraft, where he was executive v.-p. to reenter the Army Air Forces on a special assignment. His release from the company came at the request of AAF officers acting under orders from Gen. Henry H. Arnold.

IRVING TAYLOR, former general manager of the Aeronautical Chamber of Commerce, has joined Douglas Aircraft. In his new connection he will be assigned to, and work directly out of, the company's home office. His activities will include special assignments.

THOMAS F. HANLEY, treasurer and director of Dowty Equipment, has been appointed general manager of the company. Prior to joining Dowty, he was with the N.Y.C. Finance Dept.; the Income Tax unit of the Treasury Dept., and was a public accountant and tax consultant.

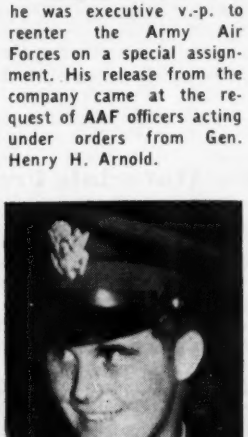
Pan American Photo

JUAN T. TRIPPE, PAA president, has been awarded the National Institute of Social Sciences medal for "distinguished achievement in the field of aviation," also the 1943 Capt. Robert Dollar Memorial Award "for distinguished contribution to the advancement of American foreign trade."

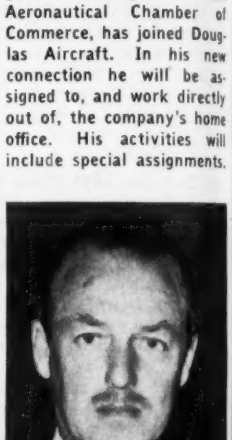


Gladsen-Mitchell Photo

ELDEN R. CARL, labor relations executive, has been appointed director of industrial relations of Adel Precision Products. Former assistant director of industrial relations for North American, he was at one time a member of the labor advisory board dealing with NRA labor relations.



LT. KENNETH W. HOWAT, former Wright Aeronautical assembly line worker, has now seen plenty of action in planes powered by the engines he helped build.. Boeing B-17 bombardier, he has received the DSC, DFC, Air Medal with two Oak Leaf clusters, and Purple Heart.

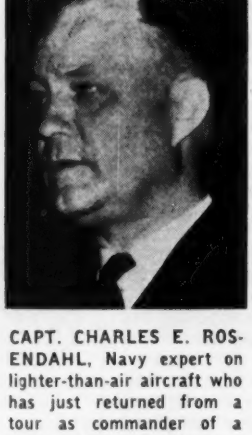


Simmonds Aerocessories Photo

OLIVER E. SIMMONDS, managing director of Simmonds Aerocessories, Ltd., is in the U. S. on his annual visit. He was recently elected chairman of the Joint Air Transport Committee of the Assn. of British Chambers of Commerce, Fed. of British Industries, and London C. of C.

RICHARD S. MITCHELL has been appointed manager of Consolidated Vultee's Consairway Division. He began his transport flying in '28 as a Catalina Airways co-pilot, and later he participated in American Export's survey flights in South America.

MORGAN C. MONROE has been appointed industrial relations director of Republic Aviation's Indiana Division. He joined Republic about a year ago as employment manager, later became assistant director of industrial relations at firm's Long Island plant.



CAPT. CHARLES E. ROSENDAHL, Navy expert on lighter-than-air aircraft who has just returned from a tour as commander of a cruiser in the Pacific, was nominated by Pres. Roosevelt to be a rear admiral. He will command airship training at Lakehurst.

Chicago & Southern Photo

RALPH L. HEININGER has been named general traffic manager of Chicago & Southern Air Lines. He joined the company in 1937 as district traf. mgr. later became assistant to Vice-Pres. Walker, then in 1942 was made acting gen. traf. mgr.

MAJ. LESTER D. GARDNER has been given an honorary degree of Doctor of Laws for "basic services rendered in the field of aviation." The degree was presented to him by Polytechnic Institute of Brooklyn at a dinner given in his honor.

Recent Books

HOW OUR ARMY GREW WINGS, by Charles deForest Chandler and Frank P. Lahm. Ronald Press Co., New York. 333 pages, illustrations, appendices, index, $3.75.

In 1909 Frank P. Lahm, then a first lieutenant in the Signal Corps, was a passenger in the first plane built for the Army. Flown by Orville Wright, the craft exceeded the prescribed one hour's flight endurance by 12 min. and 40 sec. With the late Col. Chandler, Lahm also participated in most of the early military flight experiments in this country. And from Col. Chandler's copious notes and reminiscences, Lahm—now Brig. Gen. Lahm (ret.)—has compiled a detailed, definitive account of Army aeronautics from the Civil War to the activation of the Signal Corps Aviation Section in 1914.

As Civil War balloonists and the Wrights discovered, progress was exasperatingly slow. "Our Army grew its wings the hard way," Gen. Lahm concludes, explaining that "conservatism has always been the watchword in our recognition and adoption of new implements of war, especially in times of peace." The story he has woven out of Col. Chandler's literary legacy is a modest, sturdy tribute to the men with whom both have associated—"the men who had the courage of their convictions and who persevered in their efforts, undaunted by the conservatism of some higher authority, by the lack of financial and moral support, and by the high casualty rate demanded in the development of this new weapon."

MACHINE TOOLS IN AIRCRAFT PRODUCTION, by R. R. Nolan. Pitman Publishing Corp., New York. 158 pages, illustrations, index, $1.50.

To indoctrinate apprentice operators in "the problem of mass production which is synonymous with the problem of machine tool application," Mr. Nolan has surveyed the whirling world of wheels and falling chips. As though on a tour about a plant, he conducts the reader through aircraft machine and sheet metal shops, pausing to give simple explanations of the design, operation, and uses of various tools including the hydraulic forming press, drop hammer, and high-speed metal cutters.

AIRCRAFT HYDRAULICS, by Harold W. Adams. McGraw-Hill Publishing Co., New York. 159 pages, illustrations, index $1.75.

Concentrating his discussion of hydraulics on design rather than on details of prevalent systems, Mr. Adams, chief of the mechanical and equipment section of Douglas Aircraft, explains the procedure of drawing up specifications for power and sub-systems, basic and special purpose units. For background there is a mathematical analysis of fluid flow, plus practical chapters on drafting, manufacture, installation, testing, and maintenance.

THIS EXCITING AIR, by Boone T. Guyton. Whittlesey House, New York. 219 pages, illustrations, $2.

After four years and 2,500 hr. in naval aviation Mr. Guyton, of Chance Vought Aircraft, was employed in France to check American planes delivered in the final, fatal moments of peace. His story of this job is one of the chief episodes in his breezy account of his career as test pilot. Another is his final test of a new Navy plane, apparently the *Corsair*. But adventure, he reminds his readers, is more theirs than his, for "test pilots are made, not born . . . they are encouraged to do their particular job carefully and accurately and to leave off any unnecessary frills."

FROM BIRD CAGE TO BATTLE PLANE, by Ralph Michaelis. Thomas Y. Crowell Co., New York. 248 pages, illustrations, index, $2.75. I SEEK MY PREY IN THE WATERS, by Tom Dudley-Gordon. Doubleday, Doran & Co., New York. 297 pages, illustrations, $3.

Here, two British airmen offer in their respective books, popular accounts of war in the air, accenting episodes and anecdotes which lend the flavor of first-hand experience.

Mr. Michaelis, RAF pilot in the last war and correspondent in this one, covers in fascinating detail the antecedents of the British service and its subsequent growth. Of course, the first part of his title is derived from the notorious similarity of early day planes to bird cages, there being a striking propensity of piano wire bracing (if a bird were inserted and got out, then the rigging was faulty).

British air progress, the author declares, has resulted more from self-preservation than foresight. "From 1915 on down", he says, "German policy has been logical rather than adventurous; the British adventurous rather than logical. The British started to fly late, and their flying—from a military standpoint—has been spasmodic."

The continuous activities of the Coastal Command (which Michaelis condenses into one chapter) have been woven into a book of anecdotes by Sq. Ldr. Dudley-Gordon. His delving consideration of the routine reconnaissance patrols finds a motif in the words of the pilot who called the work "just one damn' recco after another."

AN AERONAUTICAL REFERENCE LIBRARY, compiled by Willard K. Dennis. Special Libraries Assn., New York. 31 pages, $1.10.

Selected by 17 librarians, this is a list of approximately 800 titles considered essential to an aeronautical collection. Divided into about 40 fields—aerodynamics to model planes—these volumes can be purchased in the open market, it is estimated, for about $2,600.

QUEENS DIE PROUDLY, by W. L. White. Harcourt, Brace, New York. 273 pages, $2.50.

From interviews with the crew of the only one of the 35 *Flying Fortresses* on Clark Field in the Philippines to get back to the U. S., Mr. White has spun their dialogue into an exciting, sometimes humorous and idiomatic story of courage, frustration, and retreat through the Southwest Pacific in the early months of the war when we were late with pitifully little.

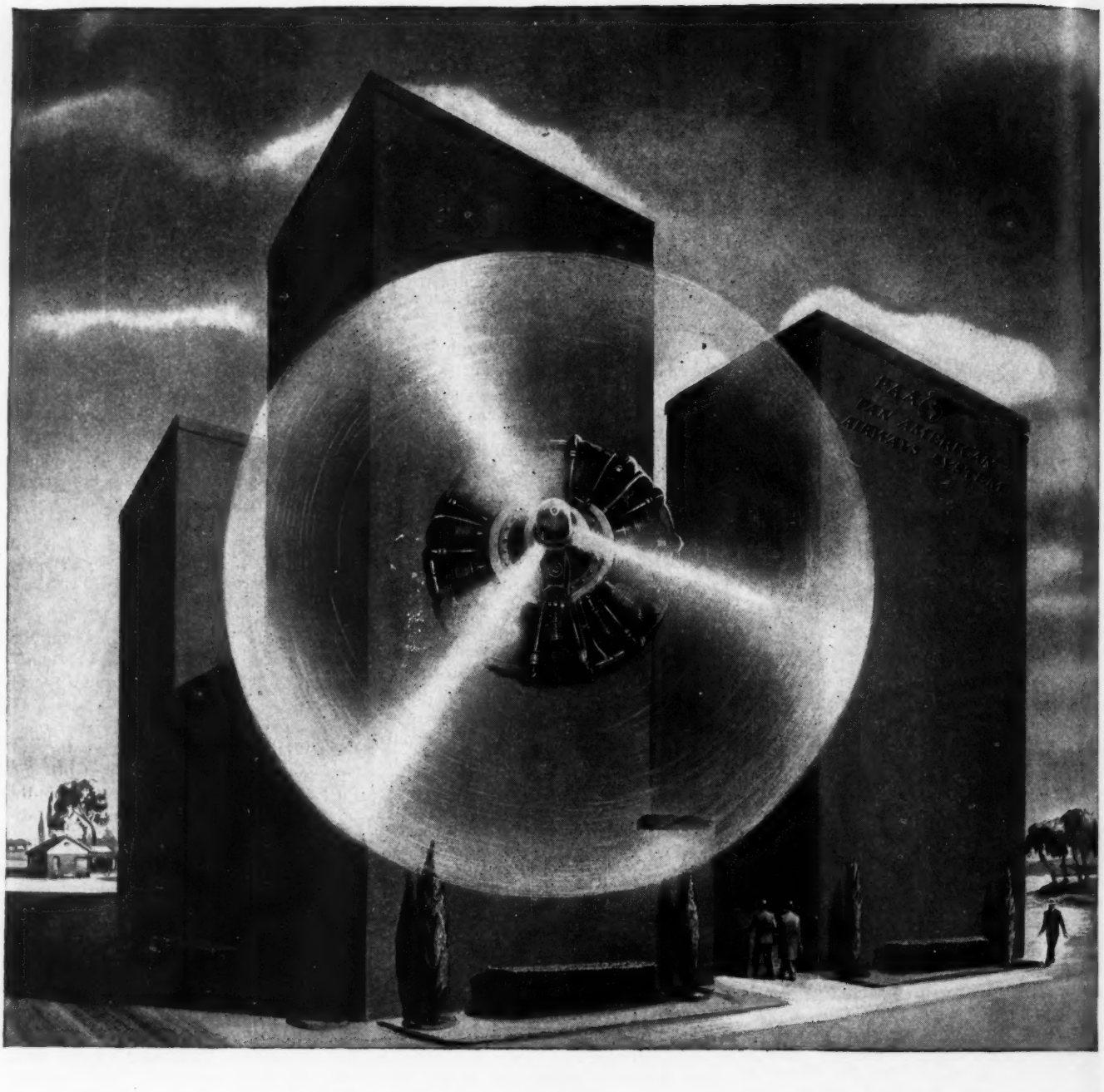
AIRLINE PUBLIC RELATIONS ACTIVITIES, by John H. Frederick and Geneva Rooth. University of Texas. 44 pages, bibliography, $1.

In practical fashion Prof. Frederick and Miss Rooth present a brief survey of publicity methods with suggestions for increasing business through them. On the premises that "the romance should be taken out of air transportation" and that despite war stimulation the public is still generally ignorant of the development and potentialities of air transport, they analyze various media for presenting "to the public a story that is consistent throughout" resulting in "cumulative effect arising from repetition of a message through different channels." Employees, they point out, are just as much a part of a line's public as its customers, and they recommend that a good understanding should be created with labor "while the industry is still in its infancy."

In a chapter on the CAB they survey, with reference to dockets, just what types of promotion expenses have been considered legitimate:

"The Board believes that traffic and advertising expenses should bear a relation to passenger revenues. But there

(*Turn to page* 382)



Cave-of-the-Winds in Miami

Inside this unique building, the engines of Pan American Clippers are put through their paces. Propellers roar with the thunder of 4000 horsepower—creating super-hurricanes as air is pulled down one set of stacks and pushed out through the other set.

Outside, there's hardly a sound—for in each stack a honeycombed unit of cells soaks up the resonance, bit by bit, until it is finally dissipated.

Naturally, this completely windowless test house had to be air conditioned—to remove heat generated by the engines, to provide controlled testing temperatures, to make working conditions bearable for the engineers. As in so many other exacting applications of air conditioning and industrial refrigeration, the equipment selected was General Electric.

Today, G-E air conditioning and refrigeration engineers are devoting all their talents to problems of war production and testing. They are learning much that will lead to better, more economical manufacturing methods—to healthier, happier living—when we return to the pursuits of peace.

Air Conditioning and Commercial Refrigeration Department, Division 437, General Electric Company, Bloomfield, New Jersey.

Air Conditioning by

GENERAL ELECTRIC

LOOKING OVER some old plane pictures the other day, we were reminded of another summer, lo these many years ago, when we were learning to fly in an OX-5 *Eaglerock* in southern Arizona's cattle country. The airport actually had a fence around it, and since that kept the cattle out the grass grew lush and green. It was a beautiful spot.

One lovely afternoon we were all set to shoot a lot of good landings (for a change) but as we took off the first time the water temperature gage, to our horror, went up and up and up—far faster than the altimeter ever could. Despite a quick turn and a down wind landing, Old Faithful was steaming at every engine pore.

That grass, which grew so lush and green, had also grown tall; so every time we got the plane up in flying position for the takeoff, the prop became a perfect mowing machine—neatly clipping the grass and blowing it back tightly into the underslung radiator.

Finally had to take a day off with a real mowing machine and clear a path, gathering a goodly portion of hay. Our horses got very fat and sassy. But all this certainly delayed flight training.

• That started reminiscences that carried on to an air show we later promoted. A feature of the day was to be a record-breaking parachute jump—from such a height the jumper would have to use the flour-sack "smoke" trail gag to let the gaping multitude know where he was. A friend in the nearest metropolis "went our bond" so that a service outfit sent a chute without the customary deposit or advance payment. Meanwhile, a more-than-usually-broke college student agreed to make the jump—for 25 bucks.

Came the day and, 'midst proper fanfare, the jumper climbed into the old J-5 Stinson to start the long climb. Finally, we on the ground saw a streak of flour smoke issue from the plane—but no jumper. Seems that on the way up he'd wanted a smoke and to get at cigarettes in his shirt pocket, he'd unhooked the front of the harness. He was squatting in the door, just ready to heave himself out backwards, when the pilot saw the unfastened harness. Somehow he grabbed the guy, pulled him in, and refastened the harness. (Then he almost had to shove him out.)

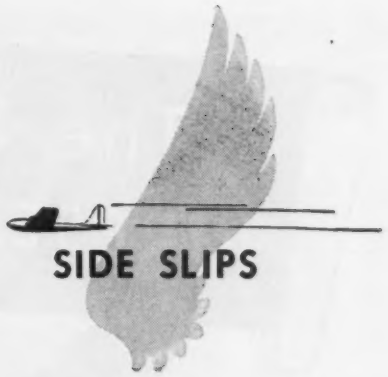
Since they could only get up 13,000 ft., everyone on the ground saw the jumper leave the plane, to fall free for a good 6,000. His descent after cracking the chute was really fast; almost as fast as the snubbing he gave us later. Couldn't blame him a bit though—we felt exactly the same way three days later when the chute owners sent a violent wire demanding payment and return of their property. Got even though; promptly wired back "Collect chute from CAA inspector who confiscated it, twelve broken shroud lines, two ripped panels, and all."

Never heard a word more from them.

• The Chinese pilot was having an awful time trying to land a hot new American combat plane just assigned him. After making fully half a dozen passes, every one high, he finally got it on the ground, midway down the field—stopping only after he'd gone through the fence into the ever present ditch. His report was succinct, to say the least, merely stating: "This airplane has tendency to overshoot field."

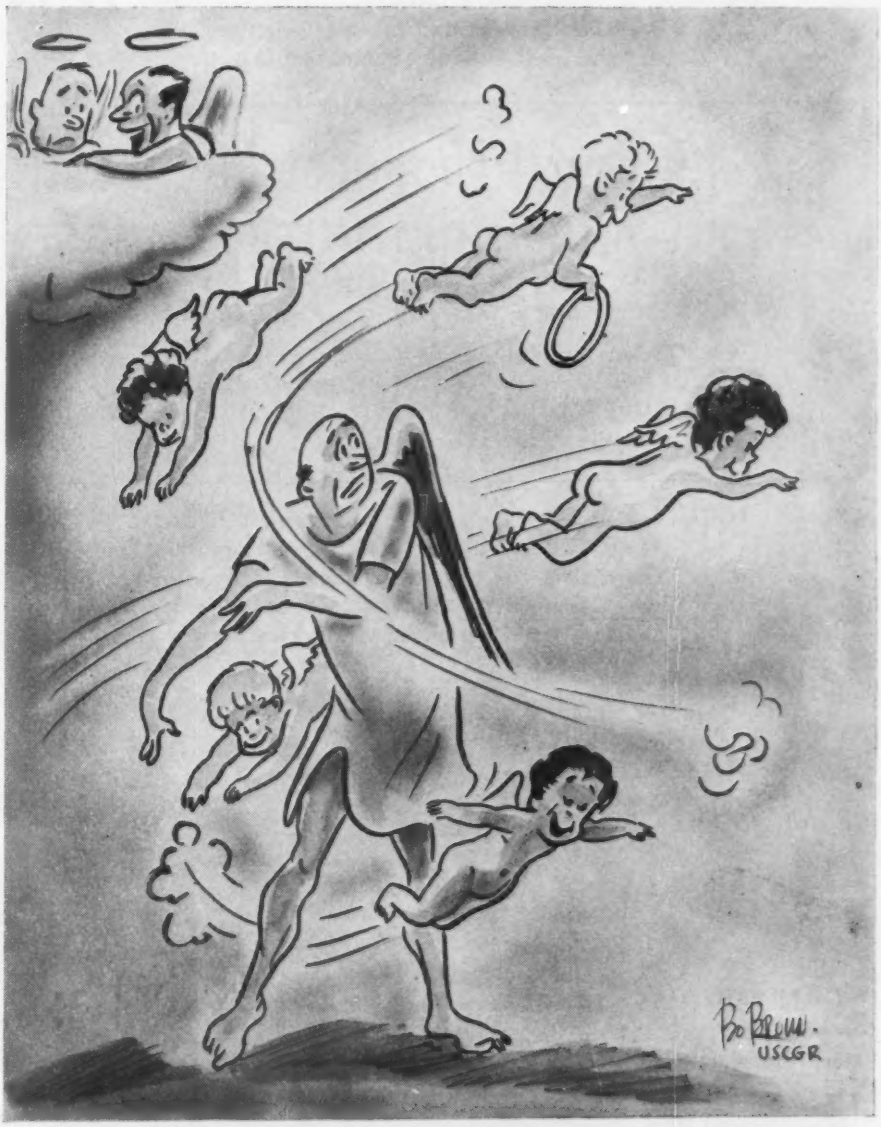
• Friend of ours got a real hedge hopping ride in the nose of a Douglas A-20—it was so hedgy they actually clipped off a tree top. "What," gasped our friend through the intercom, "were you doing then?"

Unperturbed, the pilot replied, "Just checking my altitude."



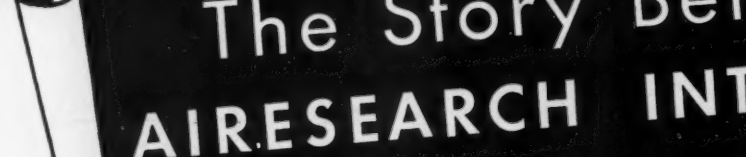
SIDE SLIPS

• After returning from his first leave in seven months, the squadron of a young fighter pilot got orders to "scramble!" He jumped in his plane so excited he forgot to turn on the ignition switch, delaying the flight's takeoff for what seemed to him interminable hours. Soon, as his engine caught, his earphones crackled with the control tower operator's bored voice: "Hit the needle, Beetle, the —— finally found his fan."



Maguire's just beginning to realize how many kids have really learned to fly.

The Story Behind the AIRESEARCH INTERCOOLER



1939 Boeing's first Flying Fortresses took to the air ...power plants supercharged for high-altitude flying. Intercoolers on this early design weighed 92 lbs. each. Designers wanted that weight cut.

1940 The assignment was given to AiResearch's specialists in air control systems. Our engineers, working with Boeing, developed and tested scores of new designs. Result—

AiRESEARCH PRODUCED THE FIRST ALL-ALUMINUM INTERCOOLERS

Weighing only 32 pounds, these new intercoolers provided a saving of 240 pounds for each Flying Fortress!

TODAY... AiResearch Intercoolers have been still further improved—are even lighter, more rugged, more efficient. Thousands of them are helping power plants deliver added useable power... helping raise the critical altitudes of American warplanes on every fighting front.

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"Where Controlled Air Does the Job"

Engine Air Intercooling Systems · Supercharger Aftercooling Systems · Automatic Exit Flap Control Systems · Engine Coolant Systems · Engine Oil Cooling Systems

"Fortresses" By Boeing

(*Continued from page* 129)

When structurally complete, front and rear sections are lifted one row forward by overhead bridge-type cranes, which span wide floor areas and greatly contribute to the ease and flexibility of assembly. In this area the units are supported in mobile dollies, where complete interior installations are made with exception of seats, turrets, and guns. Wiring, control cables, and everything requiring easy access, is put in place before the two units are joined.

This process is simplicity itself. The forward sections are moved ahead to the front of the space allotted, and placed in stationary supports. Rear sections are then brought over by crane, lowered onto mobile dollies, and pushed up to rear of the forward sections. Jacks incorporated into these dollies enable exact height adjustment to be made when the two sections are pushed together. Splices are mated, secured, and riveted. The circular bulkhead and flange are tightly bolted together and finished with a torque wrench. All connections of wires and other lines are easily managed by special terminals and junction boxes.

At this stage the bomb racks are installed in the bomb bay, and the wing control cables, wires, and plumbing connections are made ready for rapid attachment to the mating units in the wing. By this means the numerous reaching and fitting operations have been eliminated from final assembly. The bombardier's and avigator's instruments are installed forward, bombardier's seat put in place, and the transparent nose fastened on. Windows are installed in the cabin. The stinger and other turrets are not put in until final assembly.

The wing inner section jigs, occupying a large area nearly midfloor, are built together in blocks of eight. One structural support in each block extends down 40 ft. to bedrock and furnishes the key reference point to which all the other levels are checked. This is done by markers sighted-on by surveyor's transit, and adjustments are made at the base of each jig support by means of a nut. Adjustments can be made to .0005 in., and they are checked after removal of each completed wing before beginning of work on the next.

Three working levels on these jigs give access to all parts. Thickness of the wing is such that internal working space is ample. The front spar, which is built complete as a subassembly, is inserted at the bottom, with the rear spar at top. Ribs are fixed in place by spacing jigs. Control and flap motor

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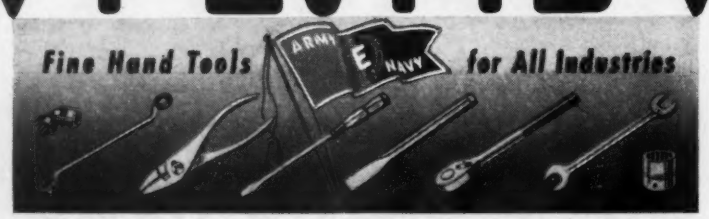
Of all the tools in the complete Plomb line, punches and chisels go against some of the toughest jobs. Plomb engineers know how to make them with points that give utmost resistance to chipping, breaking, and bending . . . with scientific design and balance to help users do better, faster work.

They are typical examples of the high quality of Plomb fine forged tools. Over 1200 kinds and sizes are on sale by dealers everywhere.

To meet the gigantic demands for these famous tools in war industries, 36 factories make them. Special tools for war needs are available also. If you need special tools . . . in quantity . . . consult the Plomb Tools Contracting Company Division. For regular tools call your local Plomb jobber.

PLOMB



PLOMB TOOL COMPANY
LOS ANGELES ▽ CALIFORNIA

brackets are installed, followed by the corrugated sheets which lie just under the skin. As the latter are applied, the engine nacelles are admitted through doors in the lower platform and joined to the wing. Landing gear brackets go on and the skin is completed everywhere up to the flap section on the lower side.

At this stage of completion, the jig is opened and the wing lifted out and laid horizontal in the aisle for reaming holes in the inner attaching face, work which cannot be done in the jig.

From here the wing center sections are lifted by crane to the next station forward, where all the final installations are made. Landing gear struts, exhaust tail pipes, turbo-superchargers, exhaust heaters, control cables, flaps, tanks, lights, radiators, leading edges, plumbing, and fuselage connections are all finished in this area, and finally, even the engine installation is completed before the unit ever touches the fuselage.

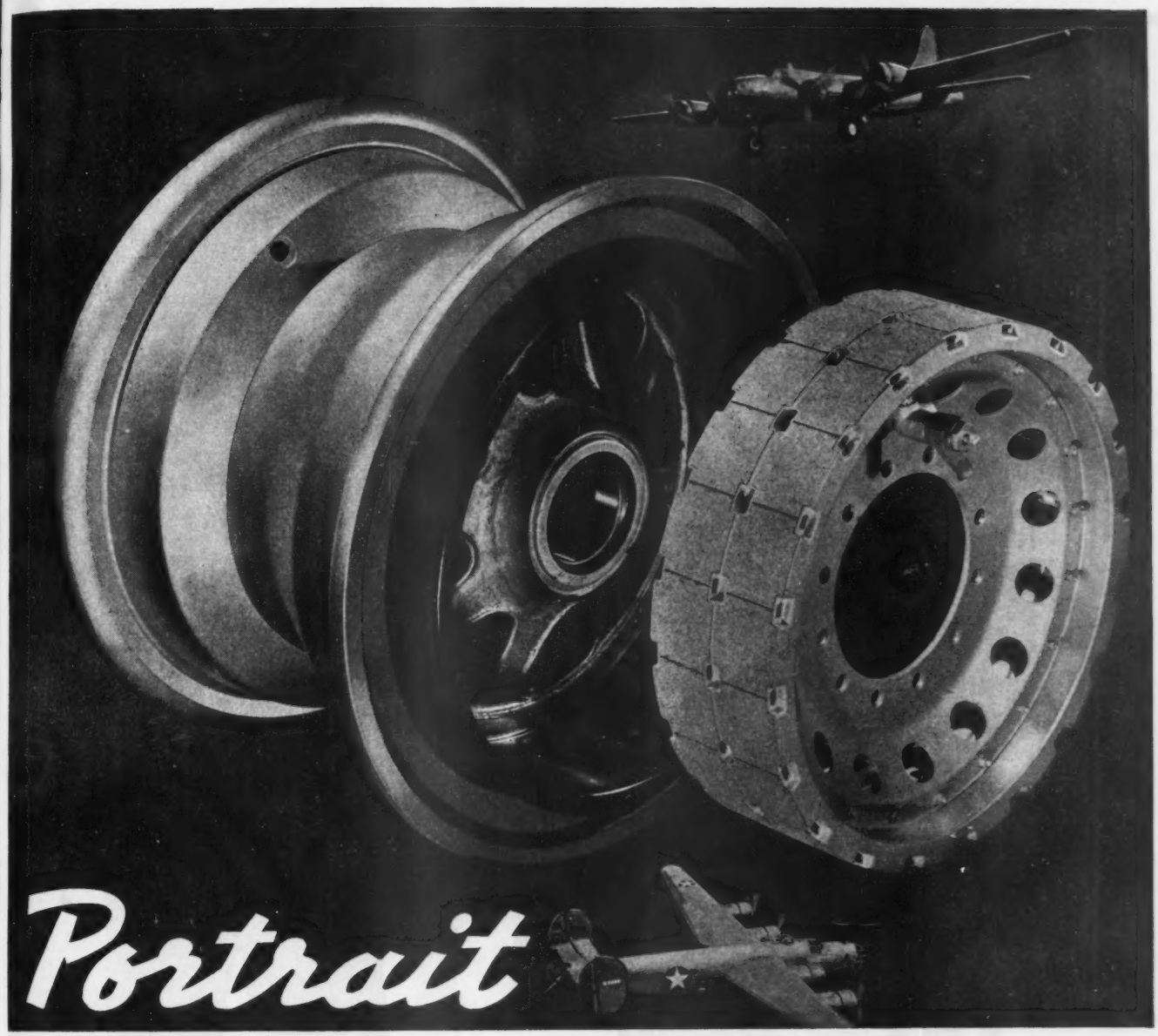
This brings the wing section abreast of the joining fixture, complete except for outer wing panels which go on later. Many parts installed here come in from outside the plant, feeding in at this point from the side of the building.

The nearly complete fuselage is now lifted forward from its station just to the rear and placed on jack supports, while the two wings are brought over and bolted on, with the ready made connections of cables, wires, and plumbing hooked up, and the fairing strips applied. The rudder, stabilizers, elevators, and wing outer sections are installed, wheels put on, turrets put in, propellers mounted—and there's the ship.

Following a few items like pilots' seats, bomb bay and rear turret doors, testing of landing gear and flap operation, and checking of the instruments with an electric test bench, the ship is lowered to its wheels and rolled forward for a final inspection.

Perhaps the most characteristic quality of this type of production is its flexibility. As contrasted with long-line work, the B-17 units are made so complete in major subsections that they can be brought together almost anywhere there is a free space. The cranes covering wide floor sections make possible this freedom of movement, while rendering constant direction of flow relatively unimportant. Some stages of assembly vary considerably in floor position according to space available. If certain processes are to be speeded, this assembly can be spread to other areas which are not dependent on line stations. Tools and materials are easily moved to accommodate.

Behind all this fluid activity is a perfect timing. If one division falls behind, it is as instantly apparent as an empty space in a line. Speeds are geared to each other and competition is promoted to keep all departments up to their best.



OF A "CREW MATE" THAT STARTS A FLIGHT . . . AND ENDS IT

"THE PORTRAIT" *Hayes Aircraft Wheel and Expander Tube Brake as used on the C-46 and other ships. Boeing B-17 Flying Fortress and Consolidated B-24 Liberator (illustrated) are also Hayes equipped.*

Slugging fight or routine flight—Hayes Wheels and Brakes mean accurate ground control in getting the ship off and landing it . . . last to leave the ground and first on the return.

War-tested in combat and training, as well as by the Air Transport Command and nation-wide airline operators, Hayes Wheels and Brakes rate "E" for Economy and Efficiency — in low maintenance cost, low cost per landing, stamina under punishing operation, ease of maintenance in the field—as well as accuracy of control under the gruelling ground variables of sand, steel, concrete or snow.

Representatives: *Eastern . . . J. Henry Reisner, Hagerstown, Md.*
Western . . . Airsupply Co., 5959 W. 3rd St., Los Angeles.

HAYES AIRCRAFT WHEELS AND BRAKES . . .

HAYES INDUSTRIES, INC. Home Office: JACKSON, MICHIGAN, U. S. A.

A CARRIAGE FOR THE *Queen*

There's an old and still unchallenged saying among soldiers that "the infantry is the queen of battle." But queens, like everyone else, are changing their ways these days and now *the queen* has a carriage . . . a troop-carrying glider . . . for the swift, surprise calls behind the enemy's lines.

This *carriage for the queen* was designed by WACO . . . is now being manufactured by WACO and more than a dozen other plane builders using WACO's design and engineering supervision.

As more and more of our troops move into battle, you can depend on it that *the queen* will be making plenty of these unheralded visits behind the lines . . . and you can also depend on it that there will be plenty of WACO gliders on hand to furnish the transportation.

The Waco CG-4A, 15-place glider is now officially known as the "Haig."

WACO AIRPLANES

THE WACO AIRCRAFT COMPANY • TROY, OHIO • U. S. A.

The production record on this world famous aircraft has been for strategic purposes, kept well under cover. But it can be revealed that it is such as to strengthen our belief in the soundness of the system and organization which has made this ship appear in force on all the battlefronts of the world.

Testifying to the efficiency of the multiline production system is the fact that Boeing, a first winner of the Army-Navy "E" award, has since received a star signifying a second six months of production excellence. This plant is currently producing eight times as many *Flying Fortresses* as it did the month before Pearl Harbor. This has been done without expanding the manufacturing facilities.

"Fortresses" by Douglas

(*Continued from page* 135)

that workmen seldom need or use respirators, and even with spraying in progress the room is almost entirely free of fumes.

From the paint booth the fore and aft section lines branch into three installation lines, two for the fore section because of the greater time required for installations, and one for the aft sections. As the sections emerge from the paint room their carriers roll into an overhead track transfer which moves them sidewise to the head of whichever line is desired, then permits them to roll forward into it.

Our stress on worker comfort and efficiency is exemplified on these lines by the conveniently placed platforms which are attached to the wing brackets and the cradle of the carriers. They ride clear of the floor, travel through the stations where they are needed, and are quickly removed when no longer required.

Since, under our system, each department tests and proves its own work, the means for doing so are provided at each point necessary. These tests are made and work is approved before a section is permitted to move to the next station. In the case of control cables from the pilot's cockpit out through the wings, a jig for establishing their correct length and testing their tension is attached to the upper wing brackets, outside of the fuselage. When cable lengths have been set, under proper tension, the jig is removed for use on another section following.

In the final station of the fuselage section lines the aft section is lowered from its carrier to a floor cradle and moved sidewise across the aisle between the two lines and placed in position for joining to a fore section, the latter remaining attached to the overhead carrier until joining has been completed.

After joining, the lower portion of the two fore section cradles are detached from the overhead carrier, the cradles themselves remaining attached to the fuselage, which is lowered to dollies that connect to the same axles of the cradles to which the overhead carriers were attached. Supported fore and aft on these dollies, the joined fuselage moves, tail foremost, to the first station of another line at right angles to the overhead lines, where the fuselages move sidewise through seven stations while tubing, wiring, and other connections are made.

In later stations of this sidewise line, the nose section, empennage assembly, and ball turret are installed. After that the fuselage moves into one of the final stations, where the right and left inner wings, transported by overhead crane from the inner wing lines, arrive and are joined.

With the inner wings in place the now rapidly shaping *Fortress* is given its hydraulic checks and inspections before proceeding to the final leg of the assembly line.

Among the Douglas-devised machines which have helped to break production bottlenecks are two drilling machines of

WE'D LIKE TO
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Our Service!
BUILDING good springs, exactly to your specifications, is what we're expected to do. Furthermore it's what we have always done and will continue to do — to uphold our reputation for quality. But today, the feature we'd like to stress is Accurate Service. It's not the ordinary kind of service you would expect from an ordinary source of supply; that isn't good enough, — today! The service we mean is the kind that's based on the complete cooperation of everyone here . . . in the office . . . in the plant . . . and in the field; not the "take-it-or-leave-it", "best-we-can-do" kind. It's the kind of service that gets things done for you — so you can do your job better and faster — so that we may more quickly return to building things that make life better — not worse.
Accurate service is for you, if you need springs and wire forms.
Get in the Scrap Now!
Accurate Springs
Write for our new Handbook of Technical Data on Springs. No obligation.
ACCURATE SPRING MANUFACTURING COMPANY
3814 W. Lake Street • Chicago, Illinois

rather unusual design. One drills the spar chord (a hollow square extrusion) and the mating extrusion cap in their correct relative position for joining. A gantry type, this machine grips the spar chord and the mating cap, together with a drill template that eliminates piloting, and drills hundreds of holes both accurately and at high speed. The drill is electrically driven with pneumatic control and has a solenoid cut-off to avoid drilling through both walls of the spar chord. Two operators, facing each other, each direct a drill as they move down the length of the chord, both seated directly above their work. Automatic vacuum clamps eliminate most of the usual tedious, time-consuming setup ordinarily required for such an operation.

For drilling the outboard and inboard ends of spars, a jig with vertical drills was developed. Both fore and aft spars are clamped on their sides while the vertical terminal drill, with floating drill chuck, locates and drills eight drive-fit holes through the spar ends and fittings within a tolerance of 0.0003. Drilling and reaming in one operation, through both chrome molybdenum steel and dural, this machine saves one complete operation and does not scratch the finish of the molybdenum or dural.

At the outboard end, another drill fixture, with radial arm, swings over both fore and aft spars to drill through spars and fittings of both upper and lower chords. Nine drive-fit holes are thus drilled in each chord. The drill is electrically driven and pneumatically controlled. Drilling operations progress at both ends of spars simultaneously. One setup is eliminated and absolute accuracy is assured for operations that fix the angle of attack of the wing.

Assembly of the inner wing sections begins in a jig which we redesigned from a series of side-by-side, stationary jigs into one jig of eight stations. Instead of assembling components and building up the wing section to a virtually complete state before lifting it out, we applied the progressing line principle here, too. Components and parts are tied together in a cradle carrier in the first station, with critical points established so those that follow fall automatically into place. Then the wing assembly progresses through seven additional stations of this three-level jig where finish riveting and other work is completed. Instead of placing the work and moving the various groups of specialized workers from jig to jig, we place the workers and move the work past them.

After leaving the jig, the inner wing sections—both rights and lefts—are turned from a vertical to horizontal position and attached to carriers of another overhead system. Assembly continues for about half the length of these lines, and after passing through a paint booth, installations are performed in the second half. The sections travel "backward," with trailing edges forward.

At the three-quarter point, the four engines arrive on dollies of our own design that permit clockwise rotation of each engine for installation of mounts and accessories. When ready for attaching to the nacelle, each engine is rolled into position, a three-segment, hinged, channeled clamp or band is released, and the engine is picked up by a hoist and raised to the joining position.

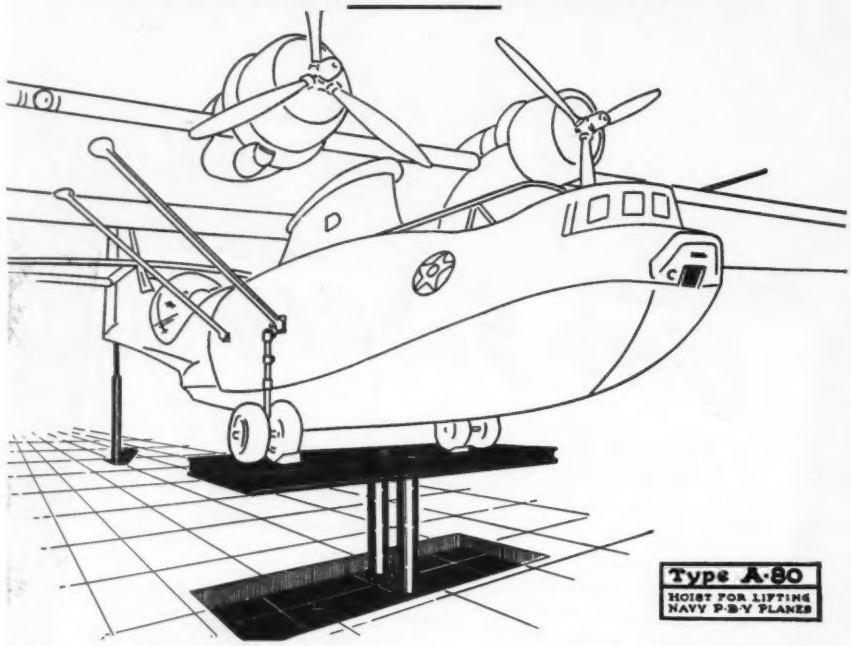
With installations complete, a check of electrical circuits is made by a unit, devised in the plant, which takes the place of normal fuselage circuits. This unit tests the entire inner wing section before final assembly.

The fuselage and inner wing lines, the former moving sidewise as mentioned before, come together at a corner of the rectangle formed by the assembly lines (actually a corner of the building). Inner wings are lifted from their carriers by overhead crane, which swings them into position for joining to the fuselage. When that is accomplished and connections are completed, the

(*Turn to page* 318)

GLOBE "ROLL ON" HOIST LIFTS PBY-TYPE PLANES

Oil-Hydraulic Platform Facilitates Repairs, "Flight-Positions" Plane for Instrument Checking

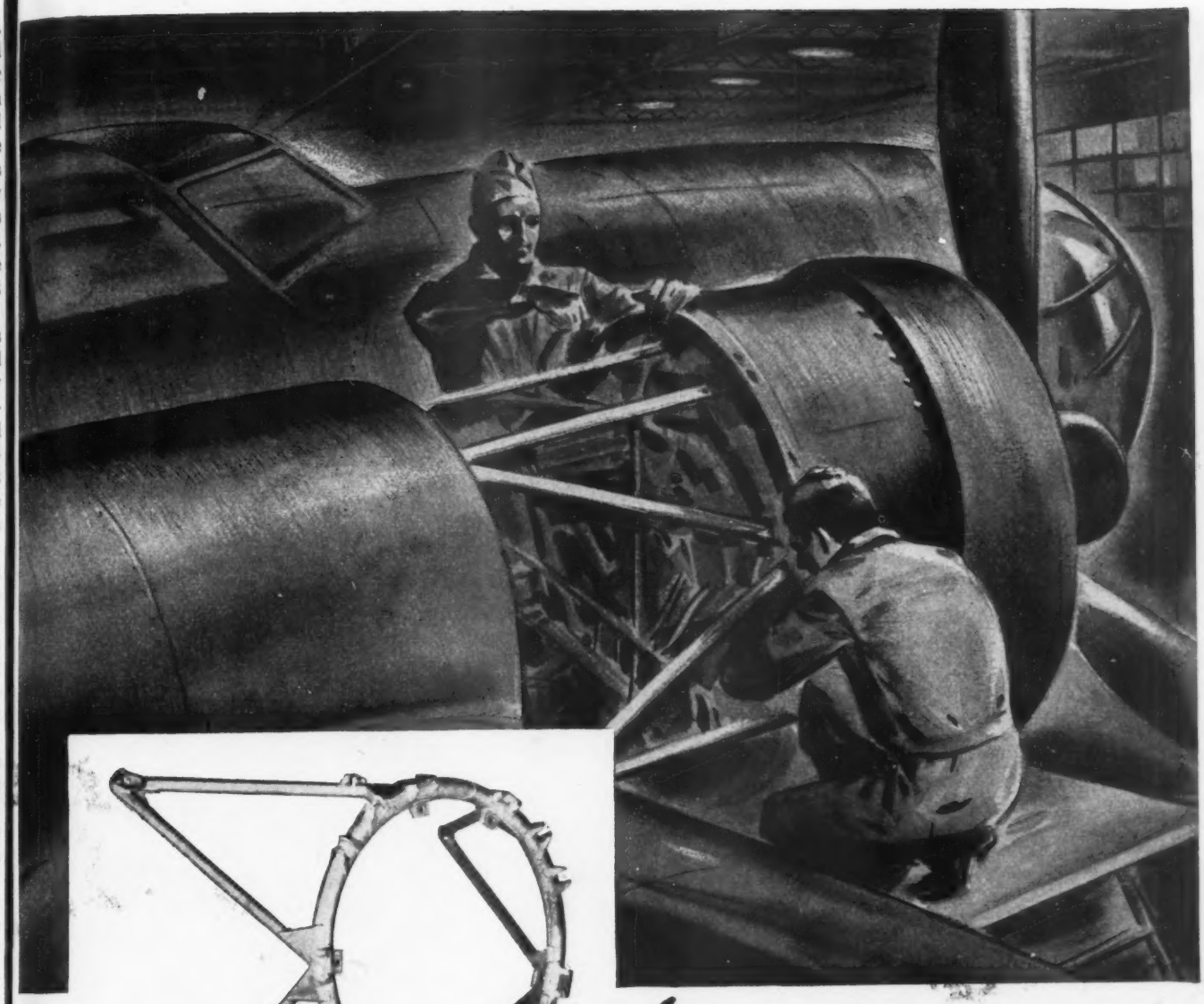


Designed to lift Navy PBY Amphibian planes, the A-80 Globe Airplane Hoist provides a quick, easy way to "flight position" these planes, as they leave the production line, for adjustment and calibration of instruments, armor and controls. Also speeds and facilitates routine inspection and repairs to the hull; or can be used to lower hull into a cradle to provide "free wheeling" of landing gear for servicing tires, etc. Hoist consists of a 3' x 15' platform mounted on dual hydraulic pistons having a maximum lift of 6' and a single telescoping piston with a maximum lift of 14' mounted so as to contact the plane's towing ring. When lowered, both units leave the floor area entirely unobstructed. For data on all types of Globe Airplane Hoists, write Globe Hoist Co., Mermaid La. at Queen St., Philadelphia, Pa.

GLOBE HOIST COMPANY

Philadelphia, Pa. Des Moines, Iowa

GLOBE
HYDRAULIC AIRPLANE HOISTS



Harness for 2000 HORSEPOWER—PLUS!

Supporting an engine at rest and harnessing its surging power in flight, the engine mount must possess a liberal margin of strength. Yet it must be light—must add the fewest possible pounds to the weight of the plane. Seamless steel tubing answers these exacting requirements.

Formed and welded into sturdy engine mounts, seamless steel tubes harness power plants and planes into superb fighting units.

MICHIGAN SEAMLESS TUBE COMPANY

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Manufacturers faced with production problems or future plans involving the use of steel tubing are invited to contact Michigan Seamless Tube Company. Development work for users of tubing is a major activity of our complete metallurgical and chemical laboratory. There is no obligation, of course.

TAKING A POUNDING . . . But Not By The Heinies

Official Photo U. S. Army Signal Corps

Sand . . . gritty, cutting and persistent . . . is a favorite weapon of the elements. Just a handful, sprinkled in the right places, can knock a plane out of action as surely as enemy bullets. Precision parts are special objectives. Take control systems, for instance . . . where sand-gutted bearings can "wobble" a plane right out of action.

Effective protection against the attack of sand . . . as well as attacks of weather and temperature extremes . . . is one of the outstanding features of Fafnir Aircraft Ball Bearings. Under all sorts of adverse conditions, these specially sealed and shielded Fafnir Bearings provide the all-important rigidity . . . yet, free and smooth action . . . that gives our Army and Navy planes their maximum maneuverability through flight after flight. The Fafnir Bearing Company, Aircraft Division, New Britain, Connecticut.

Send for copies Fafnir Aircraft Service Manual, you will find it an invaluable service guide.

ARE YOU HOARDING IDEAS?

Are you storing away in the back of your head—in safe or desk drawer—the plan for a mechanical or electrical device that you mean to bring out *after the war*? Wars always end more abruptly than they begin. How long would it take you, if the war should end next month, next year, or even two years hence, to get that product into distribution? Bring your product to us NOW! While General Instrument is at present engaged 100% in war effort, our plants and personnel are geared for the development and volume output of precision products—all set to swing into civilian service the moment the Axis runs up the white flag.

At a time when a global struggle for freedom was not even dreamed of, General Instrument was engaged in wide-scale development of peace time products like this for peace time use.

GENERAL INSTRUMENT CORPORATION

829 NEWARK AVENUE, ELIZABETH, N.J.

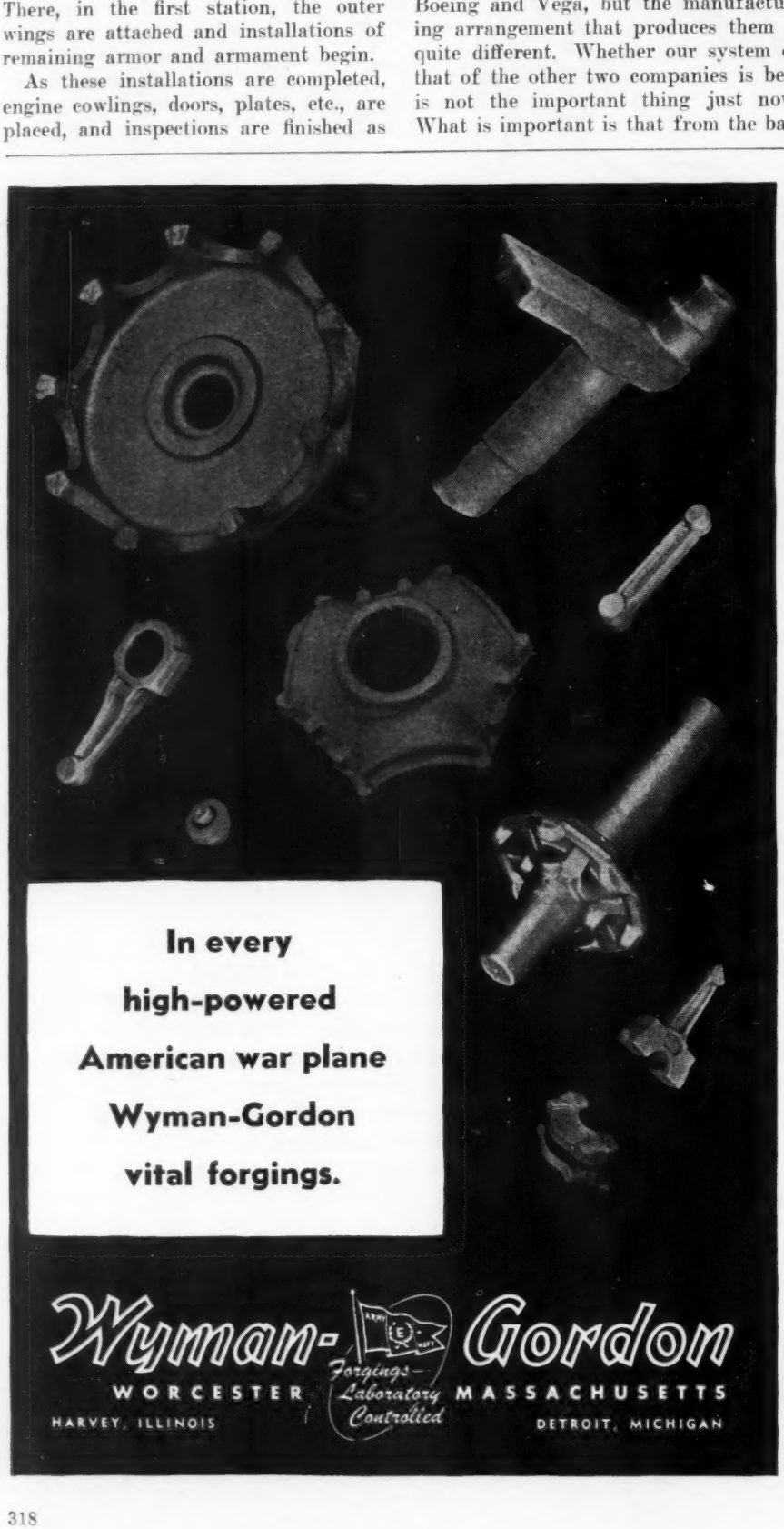
fuselage is raised from its cradles and for the first time rests on its own landing gear wheels.

After checkouts and inspections have been made and all work is approved, a floor dragline tows the plane backward on its wheels to the last leg of the assembly line, one that is longer than those previously mentioned and parallel to the fuselage and inner wing lines. There, in the first station, the outer wings are attached and installations of remaining armor and armament begin.

As these installations are completed, engine cowlings, doors, plates, etc., are placed, and inspections are finished as the plane moves into the final station where "squawks" are corrected. The now-completed *Fortress* emerges from the plant to the flight ramp, moving backward as it enters this line, with a crew of handlers furnishing motive power.

Externally and internally these Douglas-built *Flying Fortresses* are no different from those manufactured by Boeing and Vega, but the manufacturing arrangement that produces them is quite different. Whether our system or that of the other two companies is best is not the important thing just now. What is important is that from the battle fronts come increasingly frequent mentions of aggressive and successful actions by ever-growing numbers of these big bombers.

To the end that their numbers will continue to increase, faster and faster as the weeks roll by, this Douglas B-17 plant is dedicated.



"Fortresses" by Vega

(*Continued from page* 145)

craft, are started in assembly (stations 7-11) in a bank of stationary jigs, but in order not to tie up the jigs too long, they are removed as soon as possible by traveler crane and placed on castered, cradle-type dollies where pick-up assembly and installation work continues. In another Vega variation, now also being followed by Boeing, the rudder and fin assemblies are attached before the aft section is lifted from the mating jig. When the sections leave the jig they move through six stations of the pick-up and installation line, traveling sidewise.

Mention of the adoption by Boeing of the above Vega method brings up another phase of the "BDV" *Fortress* program—that is, the constant exchange of ideas and developments between Boeing, Douglas, and Vega. All three participants are constantly working out new production methods designed to expedite production and improve the ships. As quickly as anything new is proven, full information is immediately supplied to each of the other companies, and where found to be applicable it is adopted or adapted by them.

The fuselage fore section assembly method followed by Vega is similar to that used by Boeing, with the exception of breakdown of structures and skin panels to a greater extent than Boeing. From pre-assembled structures and panels, four sections are built up, complete with installations, on short assembly and installation lines located on a balcony. These are then transported by traveler crane to the main floor mating jigs where they are joined. When that is completed they are placed on carriers of a fore section final assembly line, where they move sidewise through 13 structure pick-up stations, then move forward and finally reverse direction to pass through 12 stations of installation pick-up lines.

After the fore section is assembled and equipped, the pilot's cockpit enclosure and the aft gun emplacement are added. When this is done, the section is ready for mating with the aft section. Fore and aft section, now complete, enter a joining station, then proceed forward to a position between hydraulic jacks, permanently installed in the floor, on which the inner wing

sections have been mounted. In this station the completed fuselage and inner wing sections are joined.

Upon completion of joining operations, the plane is raised and the landing gear is lowered. On its own wheels, the new *Fortress* now proceeds to the next station to pick up the nose cone and other minor items. Four of these lines operate simultaneously, but after pick-up is completed, the four lines are reduced to two final assembly lines where the outer wing panels are attached in the first of three final assembly stations. Remaining clean-up is accomplished in the second station; inspection and correction of final inspection "squawks" in the third station. The ship, now "off the line", proceeds to the camouflage shop, located in a separate building. The timing of camouflaging is the same as at the Boeing plant, where the paint shop is likewise located in a separate building.

Throughout the plant, floors of two-level jigs and other low-ceilinged working areas are painted white to reflect light. Jigs, too, are white with movable parts in blue.

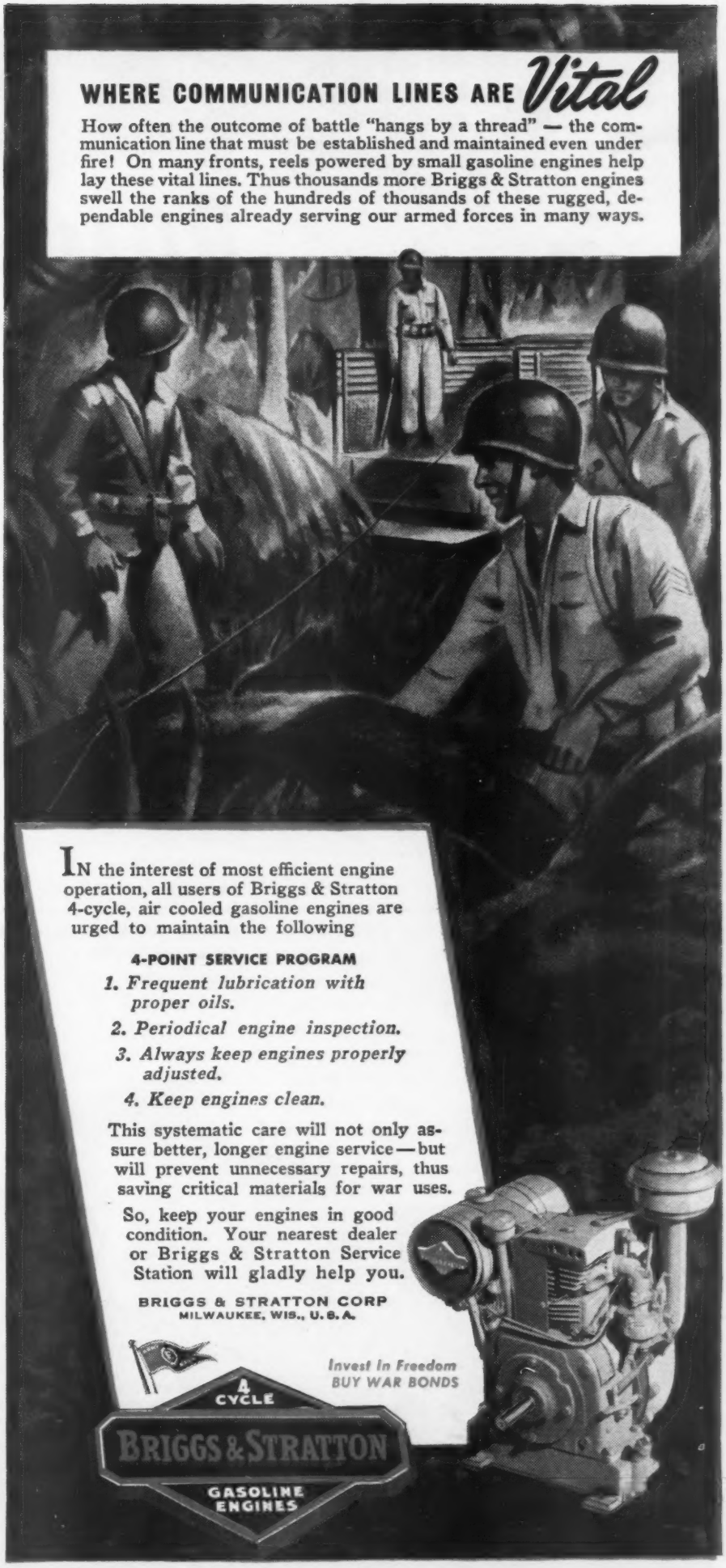
Through pre-assembly we have utilized plant space efficiently; and by getting a product as large as a *Fortress* "out the door" as quickly as possible after the ship is completely assembled and requires maximum floor space, we have held plant-space overhead to a minimum.

By pre-assembly of even the skin sections, we have reduced the time spent on large components in jigs and on assembly lines. And, perhaps even more important, we have broken down otherwise complicated assembly jobs to the point where most of them can be successfully handled by more-or-less inexperienced workers, a majority of them women.

That the method is getting gratifying results is best attested by the fact that production next month will quadruple that of Jan., 1943, yet in the first month of this year we were in full operation on the *Fortress* contract.

Later this year, and in 1944, production is expected to continue to climb, to reach a daily volume that was not thought possible when the "BDV" orders were originally placed. Some of the future increase in volume will be accomplished by further application of the pre-assembled skin panel and structural component method and by continual smoothing up of the system. The latter will include further shifting of departmental arrangements, a process now in progress which will not be completed until equipment being made is installed.

Fleets of *Flying Fortresses,* regularly darkening the skies over enemy targets, loose bombs which furnish violent evidence that the "rugged individualism" of U. S. businesses does not prevent


WHERE COMMUNICATION LINES ARE Vital
How often the outcome of battle "hangs by a thread" — the communication line that must be established and maintained even under fire! On many fronts, reels powered by small gasoline engines help lay these vital lines. Thus thousands more Briggs & Stratton engines swell the ranks of the hundreds of thousands of these rugged, dependable engines already serving our armed forces in many ways.
IN the interest of most efficient engine operation, all users of Briggs & Stratton 4-cycle, air cooled gasoline engines are urged to maintain the following
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1. Frequent lubrication with proper oils.
2. Periodical engine inspection.
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This systematic care will not only assure better, longer engine service—but will prevent unnecessary repairs, thus saving critical materials for war uses.
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THE PUNCH you need—when you need it—has been built into the G-E bomb-door drive shown below. Careful design, fine materials, and rigid tests have all contributed to making this power package one that will stand up under the toughest combat conditions. For example, one of the many outstanding features of this G-E power package is the winding structure which—because of a superior new insulating technique—is practically indestructible under the severest overloads.

TO DESIGNERS

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POWER PACKAGES

GENERAL ELECTRIC

their cooperating—as in the Boeing, Douglas, and Vega instance—in defense of this country and the world. And as those identical *Fortresses* wing toward their objectives, they furnish living proof that the ingenuity and individuality of U. S. industry is rewritting an old saying into a more modern version: "There are only two ways to skin a cat, but there are three ways to build a *Flying Fortress.*"

"Liberators" by Consolidated Vultee

(*Continued from page* 151)

has taught that such an arrangement more nearly utilizes every available foot of space in the building and puts three ships in work where normally only two would be.

An improved and simplified cantilever carriage design, plus attached scaffolding, aids the workers in reaching every part of the airplane, and the continuous movement of the assembly lines is so smooth that workers inside the ships have no sensation of motion. Carriages are painted white, not only to reflect light, but for cleanliness. Most new employees apparently are impressed not only with the tremendous production activity, but also with the constant state of cleanliness in the air-conditioned, fluorescently-lighted structure, which also incorporates white cement flooring. The latter augments both light reflection and cleanliness (see p. 166, Dec. AVIATION).

Carriage conveyors on the assembly line are valuable for many reasons, one being the elimination of the possibility of line stoppage through a shortage of any part of the landing gear, since the ship is not propelled along on its own wheels. Carriage operations allow for testing at stations of the retractable landing gear, with its complicated hydraulic system, as well as of landing flaps and other appurtenances, thus eliminating the need for a later jack-up and test.

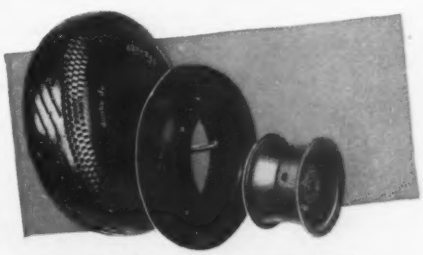
The carriages, coupled by telescoping tow-bars not unlike those on railroad cars, are pulled steadily, by compound-geared electric motors, toward the 200-ft.-wide doors at the end of the assembly building. These carriages are complete with air and electric connections so that workers may plug rivet guns and air lines directly into outlets in the moving carriages. Tracks are made of thin cold-rolled steel bars, bolted flush to the floor to enable trucks and other rolling stock to move across them without having to take long detours. Eight stations from the end of the line, a trigger arrangement on the telescoping connecting bar between carriages is released so that the bar lengthens to permit areas

—helping us to "git thar fustest with the mostest! . . ."

Of the many important tasks in aviation being accomplished with equipment made by the Denison Engineering Company, Columbus, Ohio, one of the most spectacular is the testing done by its HydrOILic Test Stand. This mobile unit, *used in the field*—or wherever electric power is not available—checks aircraft hydraulic systems. Saves valuable maintenance time . . . protects planes and men . . . and *keeps 'em flying!*

And we believe the fact this vital equipment rolls on GENERAL Jumbo Jrs. is significant. It's further proof that the Jumbo Jr. tire-tube-wheel combination is capable on *every* type of job . . . demonstrating more than ever GENERAL's famous quality!

Jumbo Jrs. roll easily . . . cushion and protect load, truck, floor or dock Traction is exceptional—filings, chip and clippings aren't picked up. Exclusive and patented, Jumbo Jrs' design makes possible service unequalled by any other industrial pneumatic tire!



Tires 8" to 24" overall diameter. Load capacity 100 lbs. to 1500 lbs. per tire. 2-4-6- and 8-ply with separate tubes and heavy duty wheels.

Available in new air corps specification sizes. Also for war orders and certain essential industrial uses.

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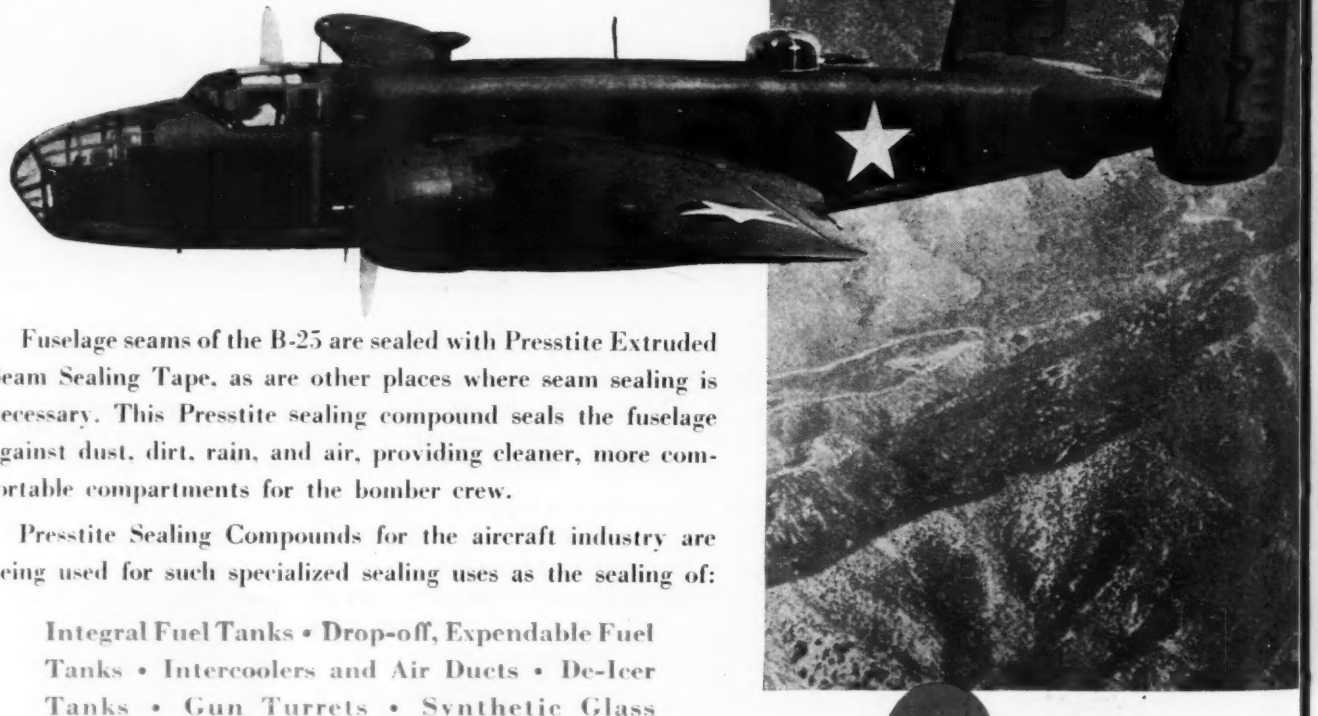
GENERAL JUMBO JR.
INDUSTRIAL BALLOON TIRES

In the North American B-25 "Mitchell" Bomber

PRESSTITE
EXTRUDED SEAM SEALING TAPE
Seals Riveted Fuselage Seams

Photo Courtesy North American Aviation, Inc.

North American B-25 "Mitchell" medium bombers were used by Major General Jimmy Doolittle on his Tokyo raid, and have been operated against the enemy from North Africa to the Aleutians and from New Guinea to Occupied Europe and Russia.



Fuselage seams of the B-25 are sealed with Presstite Extruded Seam Sealing Tape, as are other places where seam sealing is necessary. This Presstite sealing compound seals the fuselage against dust, dirt, rain, and air, providing cleaner, more comfortable compartments for the bomber crew.

Presstite Sealing Compounds for the aircraft industry are being used for such specialized sealing uses as the sealing of:

Integral Fuel Tanks • Drop-off, Expendable Fuel Tanks • Intercoolers and Air Ducts • De-Icer Tanks • Gun Turrets • Synthetic Glass Enclosures • Instruments • Seaplane Floats • Insulation of Dissimilar Metals

North American is only one of many leading aircraft manufacturers who rely upon Presstite products for a variety of important sealing applications.

Let Presstite help to solve your sealing problems, too. Send us detailed information as to your requirements and let our engineers recommend the Presstite products best suited to your needs. Write today.

PRESSTITE
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Presstite Products for War: Aircraft Sealers, Marine Coatings and Cements, and many other Special Products for the Army and Navy.

Presstite Products before Pearl Harbor: Sealers for the Refrigeration Industry, Railroads, Industrial Plants, Sewer Construction.

PRESSTITE ENGINEERING CO., 3910 Chouteau Ave., St. Louis, Mo.

between the carriages at this point to increase from 50 to nearly 65 ft., partly opening up the nesting pattern to allow for outer panel installations.

Complete coverage on installation of all large parts on the ships and on the line by the "upside down" railroad also plays a major role in continuous movement of the line. Wing outer panels are brought from their assembly area near the installation stations and added to the *Liberator* without a halt in the line. Similarly, the tail assembly (completed in a nearby place to the extent that only four bolts are needed to attach it to the craft) is dropped into place. Power plants are installed from a 90-deg. bridge over the planes. Armament, including gun turrets, then moves into place from a nearby assembly area. The bombardier's glass enclosure is left off the B-24 until the last moments in order to expedite movement of workers in and out of the fuselage.

Assuming greater importance as the size and weight of subassemblies grow is the just-mentioned "upside down" railroad. An overhead monorail crane system networking the millions of square feet of the plant's ceiling, it is used, for example, to lift center wing sections from the bucks and place them in a horizontal position on a moving conveyor line in which they are supported at each end on wheels. Wing installations then continue as the center section moves to the bomb bay fixtures where bomb bay side panels and catwalk are installed. Further down the flat line, the wing moves into place on a self-leveling and aligning mating fixture.

Finally, the power-operated, overhead-lift, 200-ft.-wide doors go up, and a complete B-24 moves from the line and out into the yard, where the concrete slopes just enough to aid the ship in rolling from its carriage as the landing gear oleo struts are inflated.

After an engine run, the *Liberator* goes to one of two large compass roses for compass swinging and calibration and testing of its complicated radio equipment.

From there it moves to the four-ship hangar, where it receives flight inspection. Shake-down flights are accomplished by experienced crews who take each *Liberator* to its operating ceiling and thoroughly test all functions for several hours.

Experience gained from Consolidated's other operations is reflected in the entire Fort Worth set-up. Even the storage problem connected with the quantity production of four-engine aircraft of this size is complex.

As a hypothetical case, say our production is 300 *Liberator* bombers and transports per month. This means we must have on hand each month 1,200 engines, 1,200 propellers, and 3,600 50-cal.

Experts at your elbow!

Here are a few of the charts, tables and other information in your Data Book:

- Dimensions and notes on gears
- Fits and tolerances
- Drill and ream notes
- Complete Air Corps Standard Sheets
- Plating formulae
- Production breakdown of typical airplane
- Weights of bar steels
- Insulated wire sizes
- Surface cutting speeds for automatic screw machines
- Welding torch tip and drill sizes
- Rod size current volt table
- Rod motion pattern—arc welding
- Set back chart for bending
- Directory of protective coatings
- Standard colors for fluid line identification
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- Rivet code
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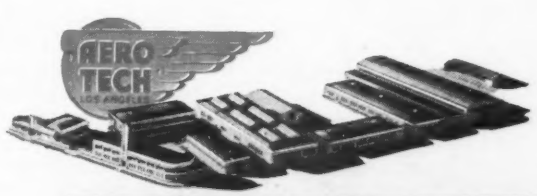
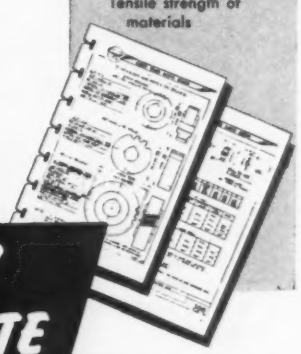
- Tensile strength of materials

Here is the book aircraft workers and students have waited for — a new "tool" that helps speed work in every department. Whatever your aircraft job, the DATA BOOK is a complete reference library, with technical tables and formulae for engineers . . . charts, tables and other information to aid every man and woman in the industry . . . plus a Dictionary of Aircraft Shop Terms.

Aero Tech is highly qualified to produce such a book, as their sole business for years has been the teaching of aircraft mechanics and engineering. Faculty editors are aviation authorities, and other information was contributed by leading manufacturers.

Ask at your plant library for Aero Tech's AIRCRAFT DATA BOOK. If you want a copy of your own, ask for it at your factory store or mail the coupon below.





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A-3-A

With that curtly classic reminder, one of America's most famous research engineers replied to a man in the act of rhapsodizing about the wonderful ingenuity of man.

For the barnacle, he pointed out, is a symbol of all those things that have *not* been done—a tiny marine organism that costs us millions every year—simple, "impossible" things that are still to be accomplished.

The development of lighter and stronger alloys, permitting 3, 5, or even 10 horsepower for every pound of engine weight, instead of one-to-one . . . cheaper color photographs and faster engravings and better television . . . swifter ways of making and working new super-hard alloys . . . scores of different kinds of rubber "growing" on factory floors, and fuels 3 or 4 times as powerful as 100-octane gasoline . . . even solar energy, and atomic power, and—remember the barnacle! These are but a few from a list of certainties and possibilities as long as man's imagination.

Under the secrecy of forced-draught war research, many incredible accomplishments—seemingly impossible within our time—have already occurred. For obvious reasons, these may not be discussed, but of one thing we can be certain: The end of this war will inaugurate the greatest era of industrial surprises since the age of machinery began.

And the shift to light metals and plastics may be as consequential as the shift from bronze to iron!

We at Bryant have developed many new techniques during the past few months. Our engineers are working on hundreds of production lines today, helping to solve production problems involving the machining of hard rubber, plastics, glass, graphite, cast iron and bronze, as well as forged, centrifugally cast and surface-hardened steels, light metals and alloys from a hundred new specifications.

If this wealth of new experience can be of value to your business, it's there for the asking. For Bryant's Consulting Service on internal grinding is available to you at all times.

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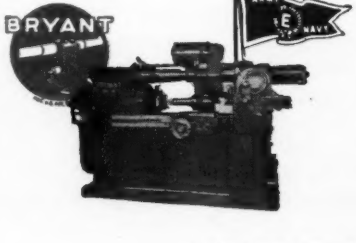

SEND FOR THE MAN FROM BRYANT

machine guns, plus turrets, armament, radio instruments, and countless thousands of "gadgets." All component parts in a ship the size of the *Liberator* are of necessity bulky.

To meet the heavy call for planes, controlled production planning is an absolute necessity. Nothing less can accomplish the maximum fluid production the aircraft industry is delivering to whip the Axis.

"Mustangs" by North American

(*Continued from page* 167)

where the interior side is sprayed. Upon emerging from the paint booth, the side panels, in two lines (rights in one, lefts in the other) progress through four installation stations before entering a master jig. Here the two sides, the top and two bottom panels, one for the radio equipment and the other the structural members of the pilot's cockpit, are joined into a main fuselage section.

Upon emerging from the master jig the now joined fuselage is mounted on a castered carrier for the trip through two legs of a rather long, continuously moving line where, in the stations of the second leg, the tail cone, empennage, and engine are added.

The carrier used on this double-back line rolls on four grooved caster wheels which run on an inverted angle iron track. A triangular extension on the front end, to which two additional, smaller, casters are attached, provides additional support and stability when the heavy engine assembly is added. Work stands, two on each side of the upright supports to which the assembly is attached by means of bolts through brackets that will later line up with other brackets on the wing, slide along the lower side platforms, permitting their being shifted to desired locations.

Engines mounted on castered stands enter the assembly area at right angles to, and across the head end of, the initial side panel lines. After progressing past those lines, they make a change of direction from sidewise to lengthwise, the front end forward, where equipment, accessories, cowl framework, and finally cowling are added in twelve stations. From the last engine line position the power plant moves through an aisle over to the second leg of the final fuselage line where it is bolted in place.

With the engine joined, the now nearly completed fuselage progresses through five additional stations where connections are completed and electrical continuity and mechanical installations are checked before the fuselage is moved sidewise into the first station of the final assembly line. There it is raised from its carrier and lowered onto the wing (already mounted on a final line carrier about normal landing gear height) and the two are joined.

Traveling backward, tail foremost, the ship passes through ten stations where final hook-up of the wing fillets is completed, its propeller added, and final clean-up is performed. Station No. 8 is company inspection, Station No. 9 cleans up "squawks", and No. 10 is government inspection. After that comes camouflaging, installation of armament, tune-up, shake down, and test flights.

After acceptance, planes to be shipped to distant fronts proceed to the shipping departments where wings, propeller, empennage, and other large components are removed and boxed for shipment. Those going to airfields in this country are, of course, turned over to the AAF for flight delivery.

Not only is the *Mustang* "designed for production as well as tactical purposes," but Royal Air Force authorities say it is the easiest plane to reassemble that they import. Because of the design that makes possible such rapid assembly and reassembly, the *Mustang* is also an easy plane to maintain and repair. In wartime, when, because of difficult operating conditions, damage to planes is frequent, that is a factor of more than usual importance.

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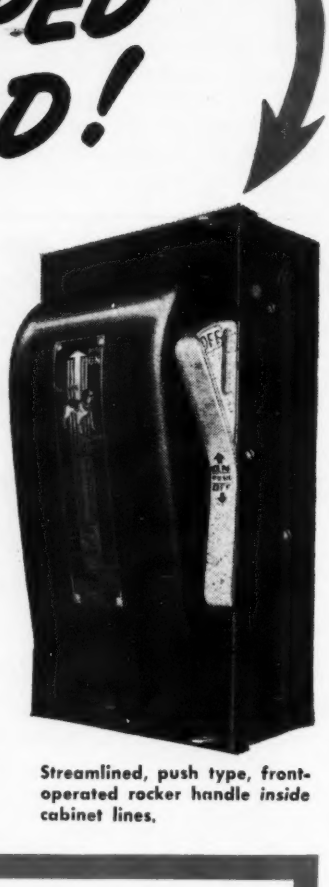
BullDog's Vacu-Break Safety Switch with "Clampmatic" Contacts provides the faster, tighter closing — and quicker, smoother opening — needed for safest, most dependable operation at lowest maintenance cost.

ON "Clampmatic" switch contacts exert a wedging action when engaged with the beveled ends of the stationary contact prongs. This wedging action puts great pressure on the movable slug, for positive pressure contact in ON position.

OFF When the handle is pushed to OFF position, the static energy stored in clamp spring helps make an easier, smoother separation of contacts. This quick-break operation in the close-fitting arc chamber creates a MAGNETIC BLOW-OUT effect which quickly dissipates arcing.



Streamlined, push type, front-operated rocker handle *inside* cabinet lines.

BULLDOG *Vacu-Break* SAFETY SWITCH

with "Clampmatic" Contacts and front-operated Rocker Handle.

Movement to OFF is speeded by release of static energy in clamping spring.

Formed bakelite cover (arcing chamber) removed from switch head to show action.

Instant, positive pressure contact caused by wedging action of moving contact when operating to ON position.

Full ON position. Moving contact now fits tightly between stationary Line and Load contacts under full clamping pressure of the spring.

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MANUFACTURERS OF Vacu-Break Safety Switches, SafToFuse Panelboards, Circuit Master Breakers, Switchboards, Bus Duct Systems— FOR LIGHT AND POWER.

BUY MORE WAR BONDS

"Avengers" By Eastern

(*Continued from page* 173)

forms set on the main platform. A few exterior jobs make it necessary to use light four-step units which are attached temporarily to the dollies and have wheels which run on the floor. In some areas, especially near the end of the fuselage line, wheeled scaffolds have to be attached to the dollies to reach points not accessible from the floor balconies.

In all, the final assembly line is nearly a mile in length, yet because it makes several loops the area occupied is comparatively compact. Although balconies run along each side of the high bays, there is plenty of room for the fuselages to pass along one side of the bay and back along the other with space between, before being shifted, while still on the dollies, to the next high bay. There are over 100 stations on the line and their average length approximates 40 ft. At each station, a given set of operations must be performed and each assembler (there are often several at a station, a large proportion of them women) has a specified part of the work to do and soon becomes expert in this job.

In an emergency, the assembler can ride beyond his or her station, usually without interfering with other assemblers. Since the operations have been carefully timed, however, there seldom is need for doing this. In the low bays between the higher ones are separate groups of assemblers who prepare wiring and tubing among other subassemblies and have them ready as needed.

A great part of the work along final assembly consists in applying such components as piping and wiring, controls, instruments, guns, hydraulic units, pilot seats, and landing gear elements. Wherever possible, as much of the work as can be done outside the fuselage is performed at benches or in special jigs where all tools and small parts needed are immediately at hand. The subassembly thus built up is then either placed in stock rooms along the line or is put in racks on the floor or balcony directly along the line where it is handiest to the assemblers who apply it to the fuselage. Stock boys keep the racks filled, hence assemblers rarely have to leave their stations to pick up parts or subassemblies which they must install. Because of the chance that assemblers may strike their heads against brackets or other projecting parts, those doing this work, especially in the bomb bay, wear fiber helmets for head protection.

Engines and the mounts which support them in the plane are received from outside suppliers and, before being placed in the plane, are combined with several accessories into an engine assem-

bly, which is built up on a special wheeled dolly in a department assigned for this job. Engines are lifted from crates by a hoist on a trolley rail and, after assembly to mounts and attachment of the latter to the dolly, the dollies progress along guide rails past bins and benches where the various parts and accessories are stored or prepared for attachment. By the time the assembly reaches the end of the line, it is ready for installation in the fuselage and is transferred to the fuselage line on a trolley hoist. This takes place just after the fuselage leaves the balconied area and emerges into the last of the high bays paralleling the balcony bays. While traversing this bay, considerable work at a high level has to be done, hence there are connected to the dolly wheeled scaffolds which advance with it and the fuselage while landing gear, engine, and other subassemblies are installed and inspected.

After the fuselage, still in the dolly, reaches the end of the last bay, mentioned above, it is disconnected from the floor chain. Thereafter it is pushed by hand on the wheeled dolly and is turned at right angles into the crane bay, along which it is advanced until completed. Wings and tail surfaces, received on truck-trailers from other plants, are unloaded into caster dollies at the end of this bay and the crane is used to transfer the wings from the dollies to the plane. Before the wings are installed, however, the tail surfaces are attached. This is done from castered scaffolds attached to the dolly and advanced with it through much of the crane bay.

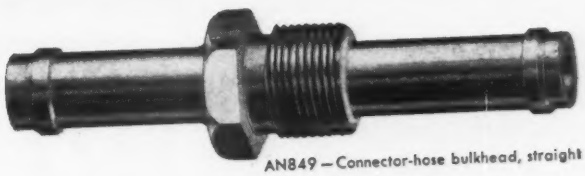
Initially, wings were installed from a fixture having three jacks, but Eastern persuaded the Navy to make an engineering change on the wing to the extent of installing a threaded sleeve at the center of gravity. This makes it possible to insert an eyebolt by which the wing can be suspended from the crane. When so suspended, the wing is very easily shifted (guided by only one man, instead of three required before) and is attached at the hinges to the ends of the wing center section. After this has been done, considerable time is required in connecting the hydraulic parts for folding and unfolding the wings and in testing the system to insure its functioning as specified.

While adjustments are proceeding, the central gun turret is lowered into place by the crane, is attached to the fuselage, and readied for test. The Plexiglas inclosures for the turret and the cockpits are also put in place and are fastened.

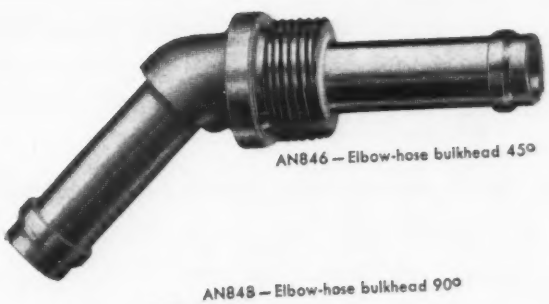
When the plane assembly has progressed about half the length of the bay, wheels are put in place on the landing gear. The tail wheel has already been installed. This makes it possible for the dolly to be removed and for the

DURAL

HOSE FITTINGS FOR PRESSURIZED CABINS

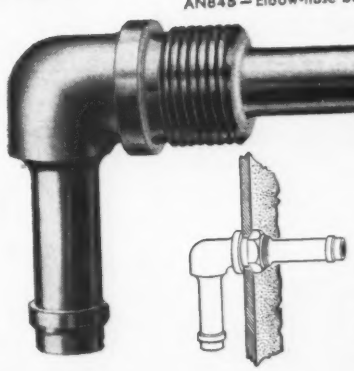


AN849 — Connector-hose bulkhead, straight



AN846 — Elbow-hose bulkhead 45°

AN848 — Elbow-hose bulkhead 90°



AN846, 848 and 849 - bulkhead hose fittings —are specified where an airtight seal for pressurized cabins is required.

Latest addition to Hartwell production parts is the new bulkhead hose fitting series, AN846, 848 and 849, designed for pressurized cabins. Produced on specially built machines and on a 'round-the-clock schedule, these parts are now available in any desired quantities, together with Dural hose fittings of the AN840 to 847 series.

All Hartwell hose fittings, except those made from barstock, are pressure tested by air, under kerosene, to 100 lbs. gauge pressure. Close production controls and complete inspection after each operation are enabling us to maintain all blueprint tolerances.

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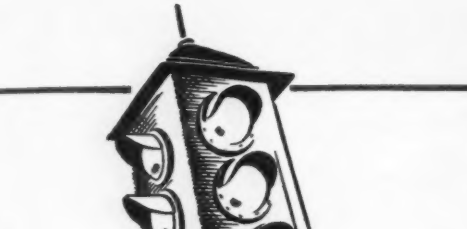


FOR THE GIANT THAT AWAITS

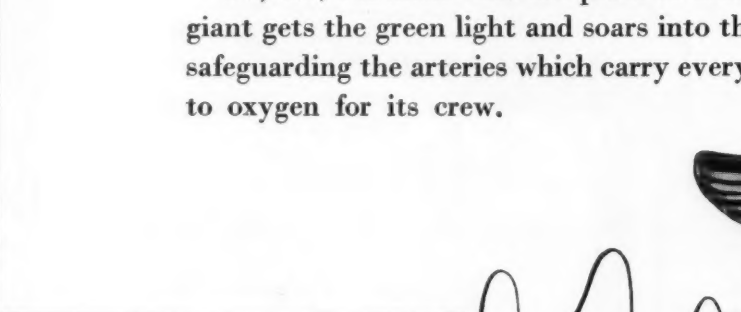
THE GREEN LIGHT

★ It will not be many months after peace comes that a new kind of bird will take to the skies . . . the mammoth cargo ship which will carry merchandise better, faster and more economically than any freighters of the past.

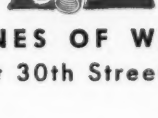
This giant is being created now in the minds of those who recognize the great future for commercial aviation. It is taking shape on the drawing boards of farsighted plane makers. It is coming to life in the designs of progressive parts makers whose vision goes beyond wartime contracts.

Winning the war comes first, naturally. That is why the millions of AFCO Fittings now being shipped are all for fighting planes. But we, too, are planning for tomorrow.

We, too, will thrill with the pride of accomplishment when the waiting giant gets the green light and soars into the air . . . with AFCO Fittings safeguarding the arteries which carry everything from fuel for its engines to oxygen for its crew.



AFCO Fittings



NEW "A-N" TUBE, PIPE AND HOSE FITTINGS

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plane to be advanced on its own wheels. But, to keep it level for test purposes, a small, high-wheeled dolly is placed under the tail. The large dolly, being at this point quite near the start of the line on which it is to be used again, is wheeled by hand back to the area beside the master assembly fixtures. In the meantime, the plane proceeds toward completion of assembly, and various hydraulic and electric tests are made.

At the final station on the assembly line and just before entering the final paint room, the plane reaches a darkened area of the bay and "targets" are applied to tail and other surfaces to check the machine gun and turret. These tests make sure that the guns and turret are so adjusted that fire from the gun cannot injure any part of the plane. This is done by attaching to the gun a small projecting device which throws a light beam against the targets along the paths of the weapons' fire.

Special care has been exercised in the design of the final painting room to assure the best possible working conditions. The room is really a short section of the crane bay but is walled off from the bay and is provided with large air-operated doors at both ends for planes to enter and leave. The room accommodates two planes at a time. All air entering the room is drawn through filters in the ceiling and is exhausted through floor trenches which carry water about a foot deep. The trenches are laid out to approximate the floor plan of the ship and are covered with grating through which the air, carrying fumes and pigment particles, is exhausted. Solid particles passing the gratings are mostly deposited on the surface of the water, from which they are easily removed and can be recovered, but any residue is caught in filters.

Down-draft through the room carries off excess paint spray rapidly and, although painters must wear masks, working conditions are excellent. When the plane is shifted into painting position, scaffolds on wheels are moved beside it, and some parts are masked. Upper portions of the ship are then sprayed and, after removing the scaffolds, the lower portions are sprayed. After drying and inspection, the ship is wheeled into the adjacent final inspection room, where radio and other electrical equipment undergo test and the ship is ready for transfer to the hangar for Navy flight tests.

War Communique No. 19

(*Continued from page* 109)

time will come when cut-back plants will simply be stopped, because there will be no other war requirement to which they can be converted.

In some cases it will be the more efficient industries or organizations that get the stop orders first. And in some cases, those who get the stop orders will be first to get going on their postwar programs. But whether the materials and the manpower will be available for postwar work at the same time the plants become available is something which cannot be predicted. You can make your own forecast by considering the war build-up in reverse. The first thing we had to have was machine tools. These have already been cut back quite deeply, and it is a question whether there will be ordnance items for some of them to convert to.

It takes only a little imagination to realize what an avalanche of war material will be free for direction against Japan when Hitler takes the count. Japan, with a steel production rate of only 7,000,000 tons when the war started (as compared with the U. S. rate of 89,000,000 tons annually) will be up against American and British production at the very apex of their power. If Russian manpower and equipment is thrown in it will be so much velvet. The American and Brit-

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MILITARY PYROTECHNICS
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Military pyrotechnics alone are not all of the war time products of the McAleer Manufacturing Company — there are others which extend into the fields of military aeronautics and hydraulics — embrace complete industrial finishing materials — metal and plastic — with a helpful advisory service — yours to command.
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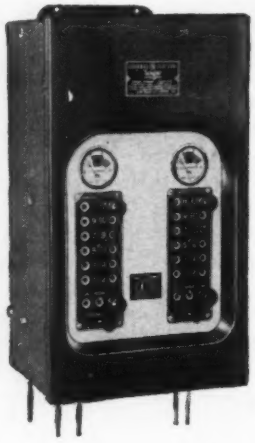
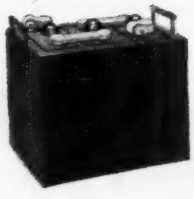


This Battery Charger



will charge 3 to 72 Cells

of Battery at 2 to 6 Amps. or 3 to

36 cells at 2 to 12 Amps.

This Full-Wave Tungar is a truly versatile battery charger. At 2 to 6 amperes it will handle 24 6-volt batteries, or 12 12-volt batteries, or 6 24-volt batteries. At 2 to 12 amperes it will handle 12 6-volt batteries, or 6 12-volt batteries or 3 24-volt batteries. It is a strong, toughly built unit designed to provide fast service. It will give a fast or slow charging rate or a combination of both. And it's economical, highly efficient and very easy to operate.

Why not get the help of G-E Tungar and Metallic Rectifier Engineers in providing maximum efficiency in charging batteries?

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GENERAL ELECTRIC

ish Navies will combine against the Nippons, and so will their air forces.

Considering the number of planes that will be available to fight the Japs, it is fair to conclude that production of planes might be cut back about that time. In fact, the Allied preponderance of power will be so impressive that some of the nationals of the United Nations may have to be prodded into maintaining interest in the war and not running off to their own devices.

Just how the war is to be won cannot be told. Mr. Churchill's remark that the attempt to knock out the Nazis by air attack certainly was worth trying, created much speculation. What did he mean? If he meant to let down on some other forms of war-making and transfer the effort to air, that's one thing. If he meant merely to keep on hitting from the air as hard as possible, meanwhile keeping all sea and ground efforts going full blast, that's another.

Obviously, ground forces will continue to get personnel and supplies, and so will the sea forces. Therefore, the "pure air power" advocates will never know, from the records of this war, whether their plan (to end the war by destroying its sources—the factories), would have worked or not. As this was written, many people were beginning to think that the United Nations attackers surrounding Germany had decided to feint invasion and hold their lines for a while, letting their airpower have a try at putting the Nazi war supply plants and transportation out of business. It looked as if the Russians might have agreed to it. These suppositions are put down with full knowledge that events may prove them wrong.

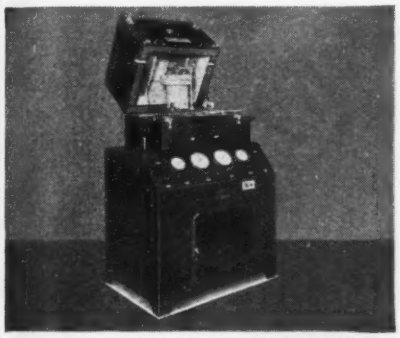
Despite how the air power is used, when the war does end the vast supply of equipment, usable in peacetime, must be disposed of. There will be hundreds of thousands of cars, jeeps, trucks, boats, ships, tools, and—most pertinent to our interests—a great fleet of airplanes.

Specific conversion of the latter to commercial purposes opens a broad discussion. Naturally interested in the building and selling of new, more advanced commercial designs, the manufacturers will emphasize the greater economies and operational efficiencies of their newly developed craft as compared with converted war models. On the other hand, the airlines may be eyeing original costs. They may believe the conversions—expected to be obtained cheaply—quite suitable during the initial "shake-down" period of peace. Perhaps Congress and the public will be advocates of the use of the conversions.

No less difficult a question is that of what to do with the factories that

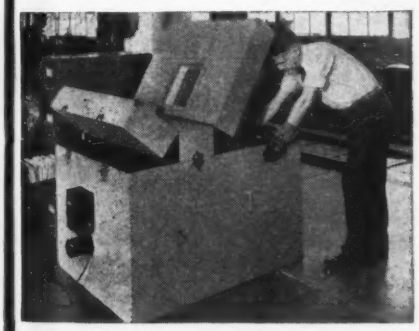
WHAT DO YOU NEED IN A LEATHER PACKING ?

Your packings requirements usually present Graton & Knight with a *development* problem . . . for few orders can be filled from the shelf. Operating pressures, temperatures, mediums, speeds are a few of the factors influencing a recommendation — the soundness of which depends not only on selection of the proper material and versatility of our manufacturing, but also on the experience and development facilities of our engineering staff. Our experience is proved by our engineers' high standing among manufacturers using packings . . . the facilities are sampled below —



HOT OR COLD OPERATION?

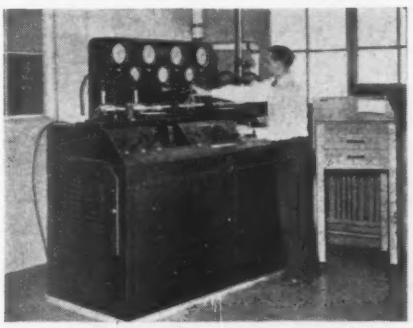
On this test stand*, assembled packings are tested under controlled temperature conditions ranging from 65°F. below zero to 200°F. above.



PERFORMANCE AT SUB-ZERO TEMPERATURES?

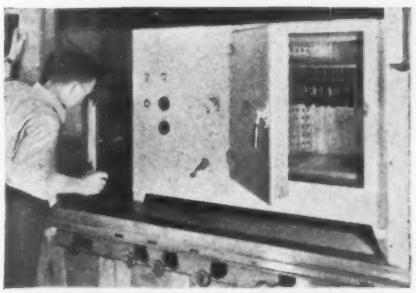
Here packings materials are tested for resistance to temperatures down to 95°F. below zero.

Built for us by Denison Engineering Company.



ENDURANCE UNDER HIGH PRESSURES?

Continuous operational cycling tests made on this unit* at pressures up to 2000 psi, determine life expectancy of any packing type or material. Leakage can be observed and measured in drops. Other equipment runs tests at higher pressures.



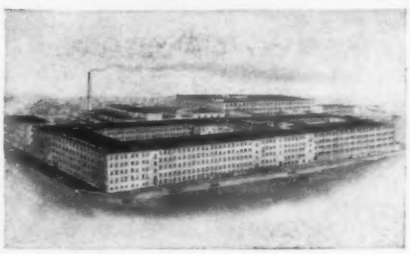
ENDURANCE UNDER HIGH TEMPERATURES?

In these ovens, changes in physical characteristics of packings materials are observed under constant, elevated temperatures.

SPARTAN

—acknowledged the top-quality packing leather

Graton & Knight's exclusive "combination tannage" produces a superior leather having chrome leather's resistance to heat and oil plus a mellowness and a flexibility not found in the usual chrome tannage. Spartan has highest resistance to heat and remains flexible at extremely low temperatures. It will not dry out hard and brittle. It is usually selected for applications within the extreme limits of leather's adaptability to packing requirements.



The world's largest industrial leather plant

Have Graton & Knight engineers tackle your packings problem while your equipment *is in the design stage.* Sometimes a slight change in *equipment design* will result in greatly improved performance and longer life.

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the hand that builds certainty at the point of seal

GRATON & KNIGHT COMPANY

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GRATON AND KNIGHT

PARTS *and the peace*

THE planes and ships streaming from America's industrial centers are not just implements of war. They are working parts of the coming peace —an economic and sociological peace wherein the freedom-starved peoples of the world will be united by ties of common interest, purpose, and transportation.

Airpower has bombed out distances! The fellowship of armies today sounds the keynote of international cooperation tomorrow. War materiel, exchanged so freely between nations, foretells of an expanding international trade in the future.

The men at the front will become our economic and business leaders. Great names in war production will remain great names in the manufacture of peacetime products. By building trainer planes and making high grade parts for the world's fastest and best fighting and bombing planes, Fleetwings has earned its worldwide reputation.

And, while Fleetwings' production records climb, the discoveries and developments of Fleetwings' engineers give exciting promise of peacetime application as well as immediate war use.

Whatever the trend, whenever the time comes, there will be no wasted time at Fleetwings. Signing off war and taking on peace will be just a matter of shifted emphasis.

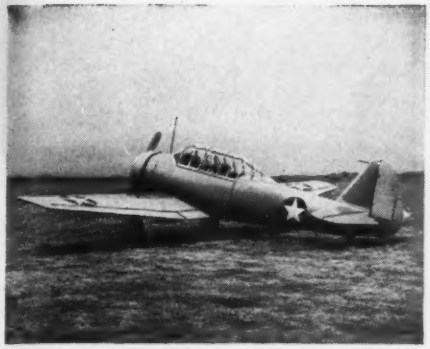
FLEETWINGS

Division of Kaiser Cargo, Inc.

Plant No. 1

FLEETWINGS

pioneers with parts and hydraulic equipment



The BT-12, all-welded basic trainer built for the U. S. Army Air Forces.

MOBILE WEIGHT UNIT saves time at Fleetwings. Conserving manpower and saving time and plant space are shortcuts to more production. Fleetwings' Weight Department has done it with a highly efficient portable weight wagon. Now, instead of the assembled parts from the production line being hauled to the scales for weighing, the scales go to them. Fleetwings production men expect the new system to save 50% of the weighing time.

FLEETWINGS' SCRAP PILE supplies the material for new fireproof welding benches. Welding operations have been streamlined by the new benches at Fleetwings. Instead of asbestos covered, they are overlaid with fire brick on a ¼" steel plate. Automatic shut-off valves operate when the welding torch is replaced in the holder.

HYDRAULICS. The Fleetwings Hydraulics Division will shortly announce a new line of valves. These will incorporate all the features developed by our designers in the past, plus several innovations which point toward increased versatility as well as peak efficiency at extreme low temperatures.

THE ARROW, Fleetwings monthly magazine, will help you to keep informed on Fleetwings production. In its pages are described the new production methods, shortcuts, and news of interest to men and women in the aircraft industry. If you'd like to receive a copy each month, write us on your company's stationery. Send your request to "THE ARROW" at Fleetwings Plant Number Two.

FLEETWINGS

Division of Kaiser Cargo, Inc.

BRISTOL • PENNSYLVANIA

made all this equipment. Several war plant and equipment liquidation bills are already before Congress. None of them is in settled form. There will be more, and there will be bills calculated to take care of the aviation equipment and plant exclusively, on the ground that they constitute a special problem. What is done about these things may mean the difference between going big and going bust after the war, for big and little businesses alike. Everyone should keep his eye on Washington—should let his congressmen have constructive ideas. Gripes will be so plentiful that any thoughtful contributions will be welcome.

The postwar international airway situation, which sounded quite difficult some time back, is beginning to lose its haze. The airlines have stated emphatically that they don't want government control or membership in any international corporations, and presumably their opinions will be considered. The head man of Pan American Airways has said he believes we should sell transport planes to foreign airlines so they can get started. And the interdepartmental air committee experts, working on a postwar policy, are indicating that they agree against government ownership and against monopoly of U. S. flag foreign services by one company. It looks as if they will propose that the nations agree that anybody can land anywhere on non-military trips, for fuel and repairs. Probably there will be no such thing as "freedom of the air" in the establishment of scheduled air routes and terminals. All that may continue on some sort of trading basis.

The British Joint Air Transport Committee, just formed with support of three powerful English organizations (the Association of British Chambers of Commerce, the Federation of British Industries, and the London Chamber of Commerce), proposes that some sort of parity yardstick be set up as a basis on which British and American international air services may be allocated. Each country would retain the right to operate between territories under its own flag as it sees fit. Russia, China, and the other United Nations (no mention of the Axis powers) would be invited to join in the parity plan. But the governments of the United States and of Britain, as such, have so far said nothing about these matters. Their decisions are yet to come.

Cruise Control for Flying Efficiency

(*Continued from page* 205)

which the most favorable wind is expected, considering time and fuel required in climbing.

3. Constant Instrument Airspeed

In maximum range operation, the instrument airspeed of the aircraft is varied as weight and winds change. If amount of gasoline used is not of utmost importance, the flight may be simplified by choosing an average instrument airspeed, which is suitable for the conditions expected, and holding that instrument airspeed throughout the flight. The instrument airspeed chosen should never be less than that for maximum range, since then gasoline and flight time would both be wasted. If an instrument airspeed is chosen which will always be greater than that for maximum range, fuel consumption is sacrificed but flight time is reduced.

Constant instrument airspeed for power control has several disadvantages. First, power must be constantly reduced as weight of the aircraft changes because of fuel consumption, thus requiring attention from the pilot at intervals of every hour or so. Second, a wheel, wing flap, or cowl flaps may slip from their best position, increasing drag of the plane. Ice formations on the aircraft are another important factor which slow an airplane. In trying to maintain the desired instrument airspeed, the pilot will be required to use more and more power and may exceed limits of safe operation of engines.

The above mentioned disadvantages may be avoided by use of the next method of power control.

4. Constant Power

Constant power is perhaps the simplest and most all-round satisfactory method of power control when maximum range is not required. A power is chosen which will yield instrument airspeeds always as great, or greater, than that required for maximum range. That power is held constant throughout the flight. Instrument airspeed will gradually increase as weight of the aircraft decreases due to fuel consumption.

This type of power control requires a minimum of attention from the pilot and immediately calls to his attention any malfunctioning of the aircraft, such as flaps or a wheel coming down, as mentioned above. During extremely long flights, it may be desirable to break the flight into two or three stages of constant power. In most cases, it will be found that use of constant power in the engine's cruising range materially shortens the time required for a trip, with very little more fuel used than on maximum range.

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AND THERE'S REASON for that talk! These resilient abrasive cloth specialties on your own portable or flexible shaft tools save time, pyramid output and improve the product.

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IT'S LIKE THAT with all the rest of these Metalite Specialties—Slotted Discs, Spirabands, Pencils and the Moulded Discs for our rubber Mushroom Pads. There's a shape, a size and a grit for every irritating, time-wasting little sanding and finishing job now slowing up some of your most important projects.

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5. Maximum Speed

(a) Maximum speed is very seldom if ever, used for any aircraft except fighter ships or racers. It is conceivable however, that when flying through enemy territory, or if intercepted by fighters maximum speed would be desirable. In peacetime operations, extreme emergency such as moving a doctor or medical serum might also justify maximum speed. Usually, however, it is not enough faster than cruising speed to justify the extremely hard usage of engines.

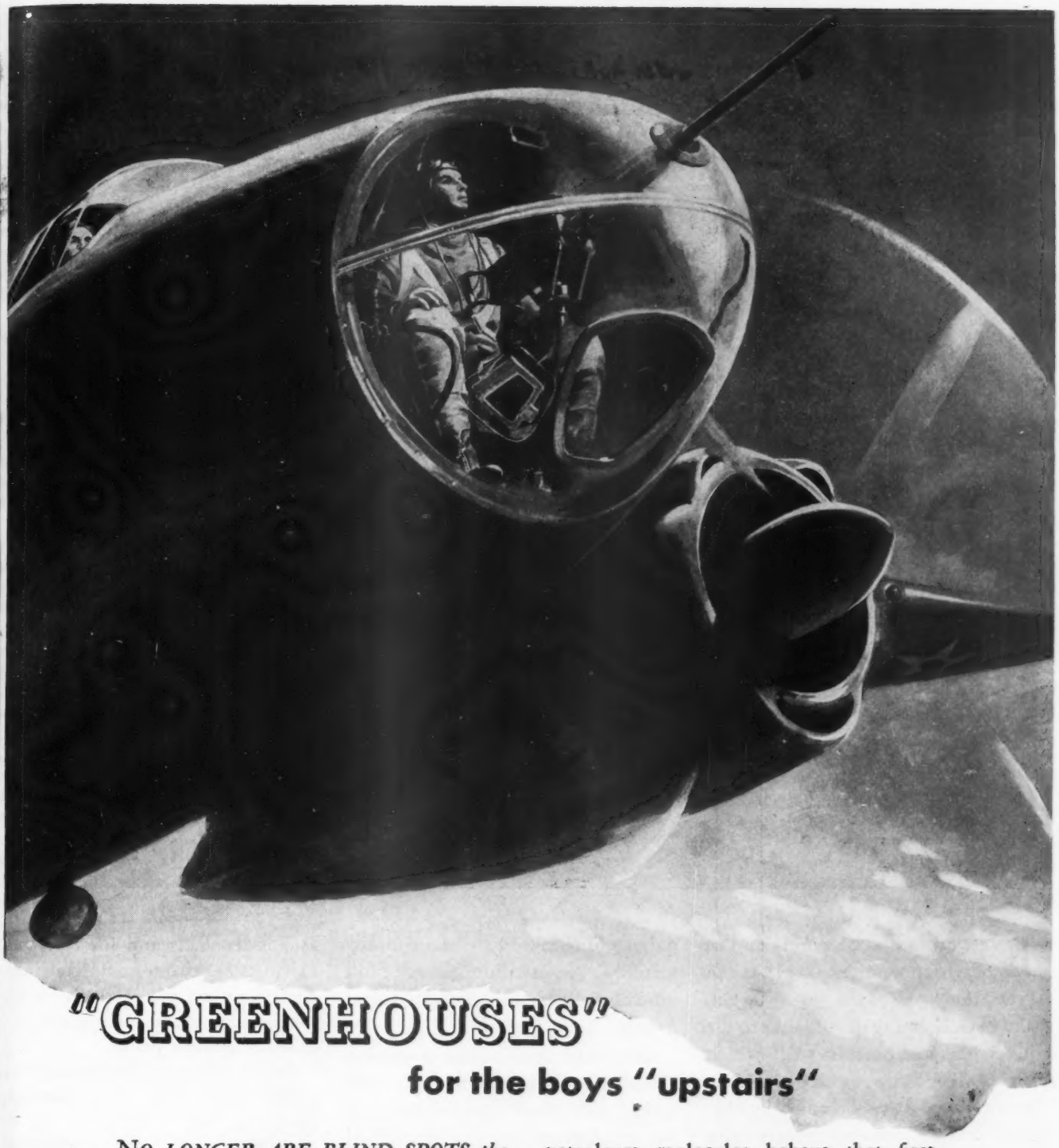
Maximum speed is limited by power output of the engines. Rated power is the maximum power which may be used continuously. Since higher speeds are attained in general at higher altitudes, maximum speed of the aircraft is attained at the highest altitude at which rated power is available. Only in cases of extreme peril would take off power be used for maximum speed.

(b) Maximum cruising speed is a more usable speed and is attained at the highest altitude at which maximum cruising power is available. For the slight decrease in speed caused by using maximum cruising speed rather than maximum speed, the decreased wear and tear on engines usually more than justifies the use of lower power. In any case where maximum speed is desired in order to cover a given distance in a minimum time (as against trying to outrun a fighter plane) it is well to bear in mind that time is lost during climb which is not entirely regained during descent, and the altitude at which most favorable winds prevail is probably best. A 10 mph. difference in wind velocity is equivalent to a relatively large change in either altitude or power.

6. Rapid Fuel Consumption

Rapid fuel consumption would be required if an airplane were required to return to its point of departure, because of a change in weather or engine trouble, and had been in flight for too short a period of time to have used enough gasoline to get down to the maximum allowable landing weight. In case of an engine failure, single-engine performance is materially increased by lower gross weight. Use of fuel dump valves will accomplish the required change in weight most easily. For airplanes not equipped with dump valves rapid fuel consumption is the only means of quickly lowering weight without throwing cargo overboard.

Rapid use of fuel is accomplished basically by using high power and rich mixtures. It is desired to keep speed of the aircraft at all times below the maximum allowable speeds for the aircraft. If comparatively low speeds are desired during use of high power, wheels and flaps may be lowered, again with care



"GREENHOUSES"

for the boys "upstairs"

NO LONGER ARE BLIND SPOTS the flyer's nightmare. Now pilots, bombardiers and gunners have "greenhouses" to let them see clearly, above, below and all around.

At the "University of Petroleum," Shell's research laboratories, a way was found to combine molecules from petroleum gases which makes possible the molding of these smooth, tough, transparent globes of open "daylight."

It is this same genius for making petroleum molecules behave that first produced 100 octane fuel in commercial quantities . . . that has helped make Shell Aviation Fuels the preference of the majority of the country's leading plane and engine manufacturers. Shell Aviation Products are also preferred by many airlines, aviation training schools, and airports.

Farsighted airport operators will find Shell's wartime popularity a profitable peacetime asset.

AVIATION FUELS SHELL **AEROSHELL OILS**

What sharp eyes they have

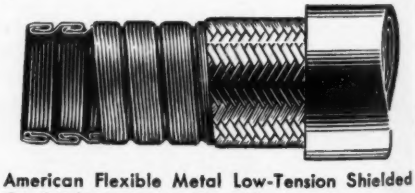
EVEN on moonless nights and in pea-soup weather our pilots can "see" their way to the enemy target, and back home again—thanks to the precision instruments with which their planes are equipped. Little wonder then that protecting the low-tension wires, the optic nerves upon which those all-weather eyes depend, is such an important task—and one that is often entrusted to American Flexible Metal Shielded Conduit.

And because of its unfailing protection, flyers hear their radio signals and instructions clearly, undistortedly . . . static interference can't gum up their teamwork as a combat group.

Allied with this line of low-tension shielded conduit, which meets both Army and Navy specifications, is American's complete line of Shielded Conduit End Connections and Fittings. Made in accordance with AC, NAF and AN specifications, larger and larger quantities of these fittings are produced every day.

American also makes stainless steel and aluminum tubing for use as hot air ducts and for conveying exhausts . . . also a complete line of flexible metal connections so vital to the continued maintenance of modern aircraft plants.

Our Technical Department will gladly assist with your particular problem.



American Flexible Metal Low-Tension Shielded Conduit for the protection of low tension wires on aircraft instruments. Available either with fittings attached or in coils with fittings loose.

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taken not to exceed maximum speed at which the aircraft is safe with wheels or flaps down.

7. Maximum Payload Miles Per Hour

Maximum payload miles per hour is an operation by use of which, during any definite period of time, the maximum amount of payload can be moved. In effect, speed is increased, requiring more fuel consumption and thus yielding a lower payload, until the product of miles per hour times payload is a maximum. Such an operation is advantageous in wartime when the amount of cargo moved with a given number of airplanes and flight crews is of primary importance.

8. Maximum Payload Miles

Maximum payload miles per dollar of operating cost is the operation which will allow an airline or a commercial operator to run airplanes at their maximum earning capacity. This type of operation is perhaps most difficult to determine since the problem of evaluating the effect of increased or decreased cruising horsepower on cost is a complete study in itself. Increased power, for example, decreases flight time, thus allowing the airplane to do more per hour of flight.

At the same time maintenance cost might be increased so that the resulting balance of revenue versus operating cost would be adversely affected. A balance must be reached at which payload miles, or revenue, is a maximum per dollar of operating cost. The problem is an economic as well as an aerodynamic problem. It is one of the most important problems encountered in determining the power to be used by an airline.

Regardless of the system of power control, flight technique has an important relationship to efficient operation. The items of flight technique which are most important in this respect are as follows:

1. Lateral Attitude of Airplane

Careless flying by a pilot may allow the airplane to be flown with one wing lower than the other. Such an attitude results in decreased efficiency of the wing airfoil section, which calls for a greater expenditure of power in order to obtain a given airspeed as compared to "level flying", or with a constant power the speed will be less when flying with one wing low. Therefore the airplane must be flown in a laterally level position at all times. Air turbulence, of course, will sometimes make the leveling technique extremely difficult and at times an impossible task.

When an airplane is flying with one wing low, it is either skidding or making a normal turn. In straight flight with one wing low, the skidding airplane experiences a loss in aerodynamic

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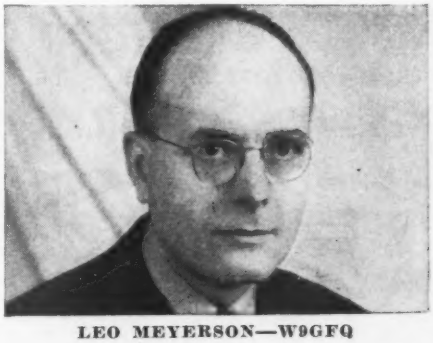
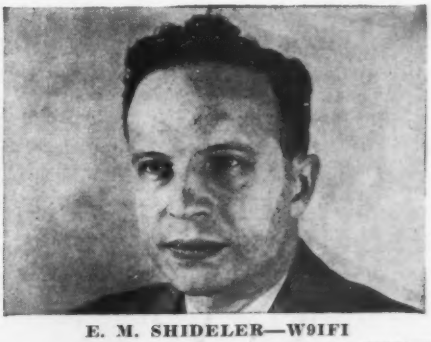


LEO MEYERSON—W9GFQ



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efficiency. Hence, the pilot must be aware of the fact that more miles per gallon as well as more miles per hour result when he maintains the airplane in level flight, giving careful attention to avoidance of "low wing" flying.

2. Air Turbulence

Flight through turbulent air is in reality flight through vertical air currents. In maintaining level flight through turbulent air, the pilot must alternately climb and descend with respect to the air in order to maintain a constant altitude. Constant climbing and descending means a corresponding change in airflow conditions over the wing with a decrease in aerodynamic efficiency. (An additional loss in efficiency from alternately climbing and descending is discussed under item 3.

The pilot must be advised to seek smooth air levels for cruising insofar as possible. He will, of course, usually prefer smooth air because of comfort considerations. Smooth air is not always at hand, however, and wide detours cannot be supported by differences in efficiency in rough and smooth air.

3. Maintenance of Constant Altitude

Even in smooth air some pilots have a tendency to alternate between altitudes unnecessarily. All altitude changes should be kept at a minimum because of the efficiency loss involved. When an airplane changes altitude and then changes back, all on a constant power basis, more time and therefore more fuel is required to fly a given distance than if a constant altitude were maintained. If power is changed in order to make the change in altitude without loss of time still more fuel is required.

This loss in efficiency ensues because the power advantage obtained during descent does not fully offset the power disadvantage of a corresponding climb. Such is the case because of speed—power relationships at high (descent) and low (climb) airspeeds and propulsive efficiency considerations where power from the engines is absorbed through the propeller for climb with resultant propulsive efficiency losses.

4. Extraneous Drag

Every care must be taken to be sure that the airplane is as aerodynamically "clean" as possible. The pilot can do much toward seeing that all retractable items are in fully retracted position during flight. Cooling flaps unnecessarily open, landing gear doors not fully closed, landing gear not fully retracted, wind flaps not fully raised—all are detrimental to flying efficiency. Pilots must learn to watch speed-power relationships, and when slower airspeeds are experienced than "the book calls for" they must investigate to see if anything is dragging.

5. Changes in Power Conditions

Whenever either of the power control conditions (propeller speed or throttle opening) are changed there is an over-all speed or fuel loss. During a maximum range or constant airspeed flight, however, it is necessary to change the power conditions in order to operate at optimum airspeeds. This change in power can be accomplished at intervals of one or two hours and more frequent power adjustments should be avoided.

6. Use of Engine Superchargers

All present day engines have a basic supercharging element and some have an optional higher compression available. An engine supercharger does not give something for nothing. Actually it absorbs engine power in compressing air to provide a higher power output at higher altitudes. As long as the desired power can be obtained without using added supercharging it is best from an economy standpoint not to use it.

The straightforward problem of power adsorption in air compression is basically clear, so the pilot will easily understand the power penalty involved in its use and will therefore minimize his use of added supercharging to climb above undesirable flight conditions and to take advantage of favorable winds.

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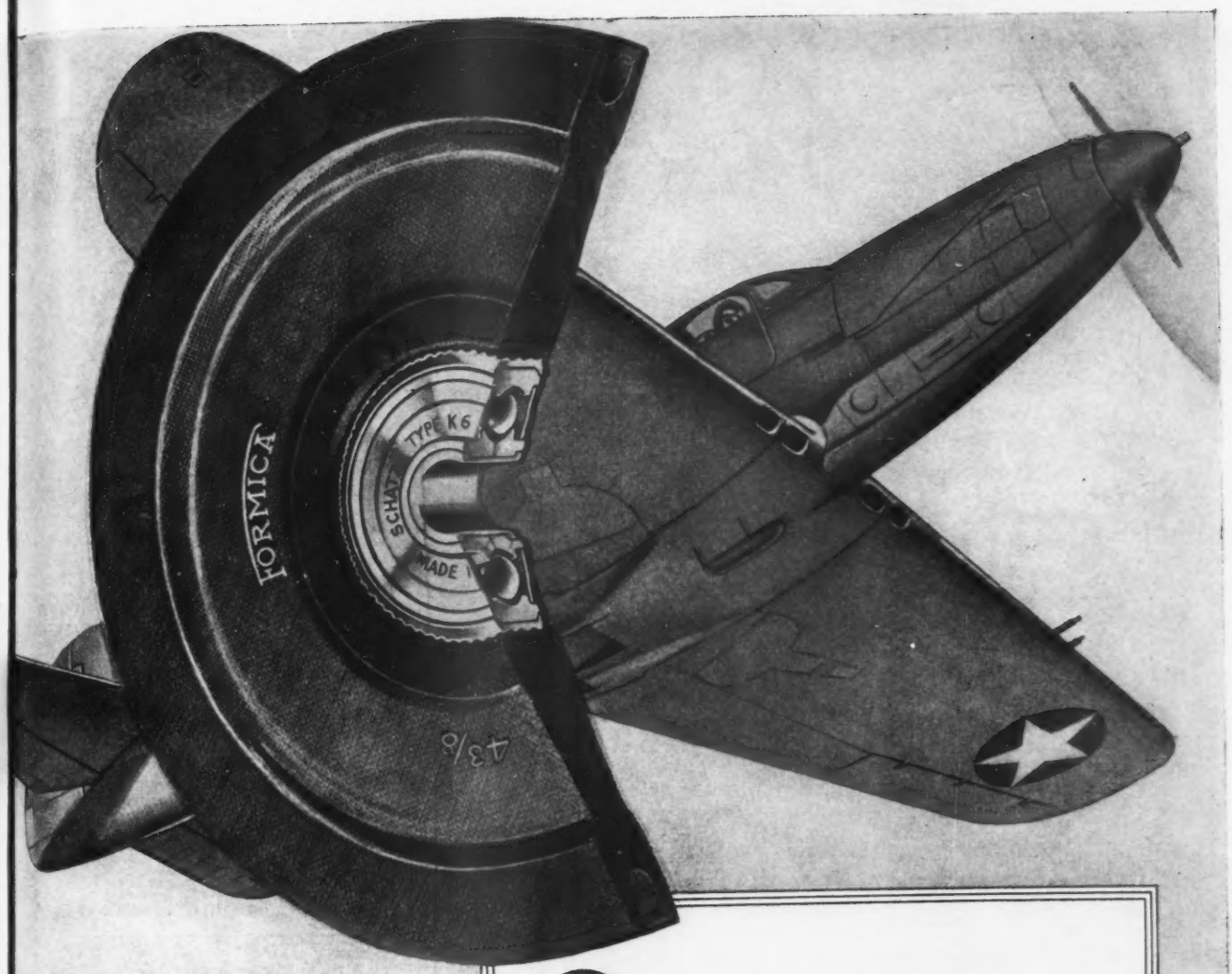

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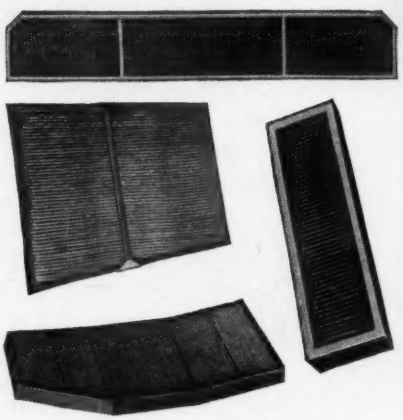

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Zyglo reveals cracks in cast aluminum valve body.

ZA-2D Zyglo unit, one of a complete line designed according to the size and volume of parts to be inspected. This is a single compact unit. Others for larger volume consist of sectional units for each step of the Zyglo Method.

There is scarcely a more practical time to peer into the future of a plane part, engine casting or weld than just before assembly. "Zyglo," the new Magnaflux* Method of accurately reading the future of a piece of fabricated aluminum, brass, magnesium, austenitic steel, porcelain, plastic, etc., enables shopmen to forcast areas of probable failures. It is not a laboratory but a practical shop technique. The equipment takes its place on the production line. The entire inspection operation is planned at a speed to keep pace with production.

Results: Clear, easily interpreted fluorescent indications under black light. Routine handling without delaying the flow of work. Big direct savings of labor wasted when defective parts are assembled. Enormous indirect savings through prevention of failures.

The Magnaflux Corporation's pioneer work in the field of non-destructive flaw detection provided a sound basis for the rapid development of Zyglo Inspection Equipment. The new method, while opening up an entire field of non-magnetic as well as magnetic parts inspection is similar in routine and application to the widely known basic Magnaflux* Method. Design of dipping stations, rinsing and drain tables and the curtained booth where examination takes place under black light took full benefit of past experience with factory inspection installations.

Post yourself on the possibilities of Zyglo in your production. Write for the new Zyglo Bulletin.

**Magnaflux — the Trade Mark of the Magnaflux Corporation applied to its equipment, materials and methods for magnetic particle inspection.*

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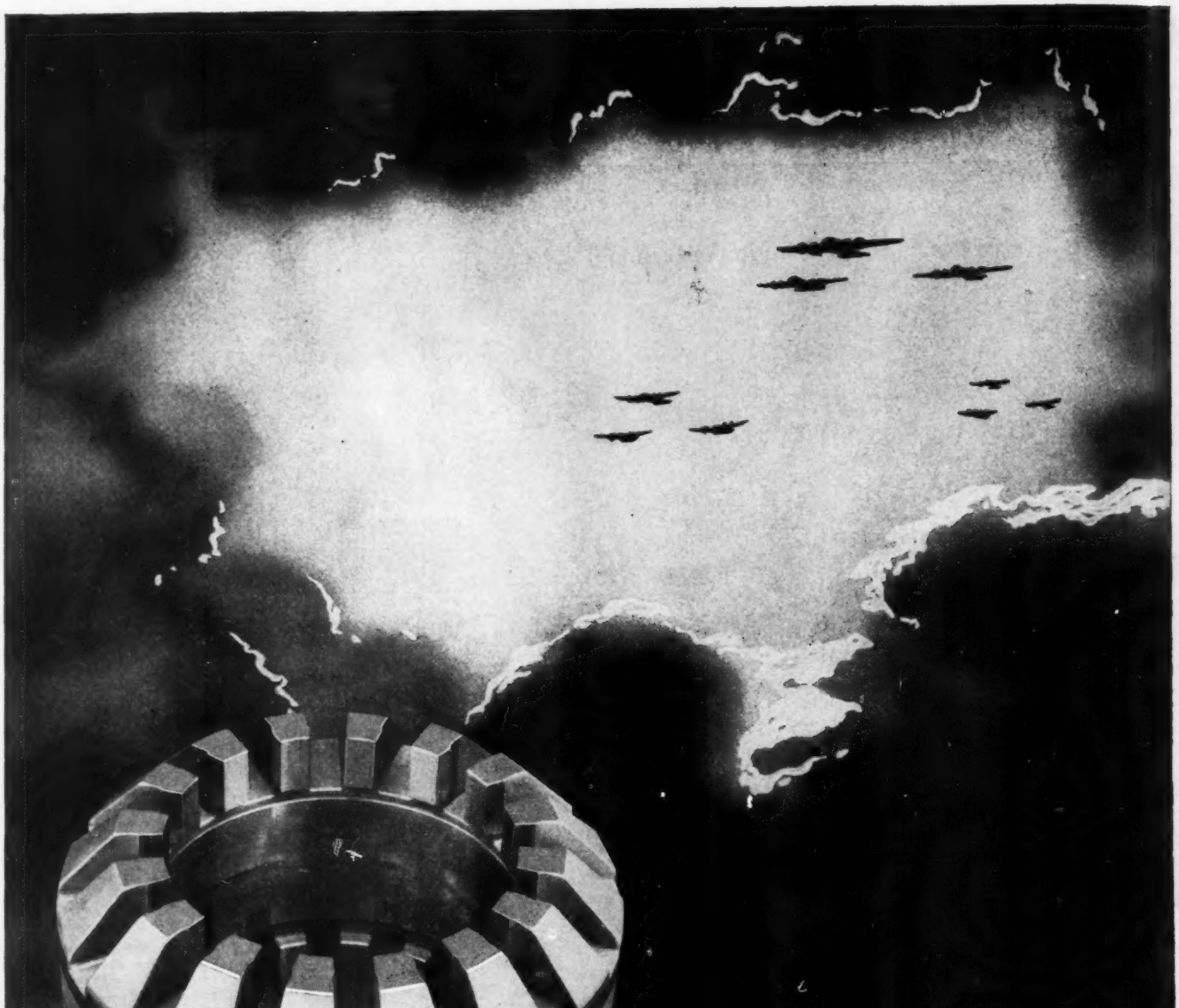

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Short, snappy hops to flatten submarine bases on the coast of Occupied France—block-busting visits to Essen and Cologne—softening operations on Bizerte and Tunis—cracks at Jap fields in New Guinea and Kiska—Shangri-la raids on Tokio—all of these use planes, planes and more planes! The almost 7000-plane-per-month production here in the U. S. would not be possible without those "production multipliers," those "precision inspectors"—GAGES. . . . VINCO is making thousands of gages for use in the rapid production of planes.

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MILLIONTHS OF AN INCH FOR SALE BY VINCO

Mid-year Checkup On Finance

(*Continued from page* 114)

ment boards can do for those aircraft companies that are asking for some provision for postwar reserves when their contracts are being renegotiated. Congress alone can define the tax status of postwar reserves.

The 16 companies shown in the chart set aside postwar reserves aggregating $36,131,000 in 1942, compared with $14,-120,000 in 1941—a good beginning but hardly enough for a $20,000,000,000 industry. Thanks to Congress, they also were able to accumulate postwar tax credits of $17,792,000 last year.

Glenn L. Martin, head of the aviation firm bearing his name, put the issue rather forcibly before Congress recently when he warned that unless the lawmakers provide some means whereby industry can set aside reserves before taxes for peacetime reconversion, American industry will be threatened with collapse after the war.

International Overhaul

(*Continued from page* 212)

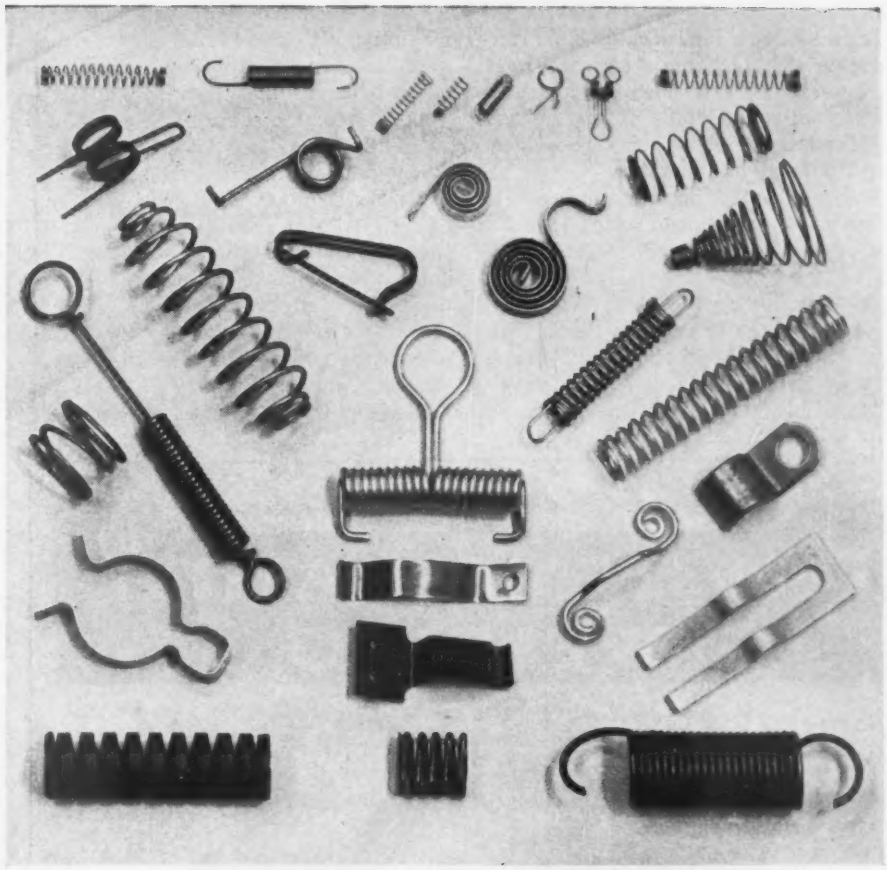
rebuilt from parts supplied by the Army. Liquid cooled engines have not come through in sufficient volume to warrant overhaul equipment for this type, so they are sent away.

Douglas C-54's have been in for service and checking, and in one case an engine had to be pulled and a new one installed. Curtiss Commandos which have been working for the ATC, also are occasional visitors at the repair base. One of these was reclaimed from what at first was declared a total loss. There has been much praise from all sides on the utility of this craft.

For *Ansons* and *Oxfords*, extensive woodworking facilities have been set up. The shop is equipped for plywood forming over molds, building up of laminates in a glue press made by the plant, and all types of wood cutting and finishing. Assembly of frames in jigs and complete rebuilding from ample parts stores sent in from manufacturers are performed.

As is usually the case when equipment has to be built on the spot, many ingenious ideas have come to light. The balanced, roll-over wing dollies (illustrated) are good examples, and these serve a particularly good purpose in view of the large percentage of women employed—somewhere near 40 percent—involving the same problems of work simplification which have influenced our manufacturers.

Fuselage jigs have been made which



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are easily rolled about on casters but which can be accurately fixed and leveled by turning down four jacking bolts running through the frame corners. Lugs on lower end-frame members are filed to true horizontal plane of the jig and the checking level is set across them when the bolts are adjusted.

The number of planes repaired per month runs in the neighborhood of 50, and may include any of the following types: Avro *Anson*, Airspeed *Oxford*, North American *Harvard*, Noorduyn *Norseman*, Barclay-Grow, Beecheraft, Bristol *Bolingbroke*, and many others which may not be enumerated for military reasons.

One particularly useful organization within the company is that of field service units. It was found that damage to aircraft was very often greatly increased by unskilled packing and shipping-in from the scene of accident, not to mention that very often sending in of the whole craft was unnecessary or an on-the-spot job was feasible. Groups of well trained men are kept in continual circulation among the schools, doing field repair, supervising dismantling, and crating of planes for factory attention. Control boards in the superintendent's office show the disposition of men about the country at all times, with colored tags representing foremen, leadmen, etc. Each training field is alotted a board.

The engine overhaul shop, especially well set up and systematized, turns out a creditable volume of work which is meanwhile handicapped by wide variety of types. These are mainly Armstrong-Siddeley *Cheetah* Nines and Tens, Jacobs L4M's and L6M's, Pratt & Whitney *Hornets* and H. *Wasps*, Wright *Cyclones*, and occasional Continentals.

Six test stands and exceptionally efficient and well ventilated cleaning tanks obviate any bottleneck which can develop at these points. Crated engines are unloaded and given a preliminary cleaning spray before disassembly. When completely taken down and placed on racks, all parts go through the cleaning tanks and are sent on to finish-cleaning benches where hard carbon is scraped and inside surfaces hand cleaned.

As parts come through this process they are arranged in groups and placed on parts racks which are marked and spaced for all components of each type of engine. This has been a great aid, with increasing use of women and new untrained help, to keep parts classified and to make visible at a glance any missing items, which can then be checked back to the cleaning tanks before proceeding further. Stores girls require much less training because all part spaces on the racks are numbered, so that it is not even necessary to know the part names.

Additional careful planning in this direction is shown by neatly arranged tool boards, also with numbered places. The boards are arranged in groups according to make of engine, so that the wrong tools will not be mixed with other types.

There is careful inspection, with magnaflux and precision measuring sorting out serviceable, repairable, and condemned parts, which are tagged accordingly. When racks proceed to the stores department, rejects are taken off and new replacements placed in separate boxes on the rack to keep them apart from the items already inspected. Since new parts must also go through inspection, time is saved by segregating them here.

From the stores division, racks are routed into the repair bay, where parts are split up according to different sections of the engine, with each group in charge of different men who specialize on those units. All repair work is done here and the parts replaced on the racks. A final check for accuracy, selective fit, and completeness of assembly components is made before the racks are sent to the assembly lines. As far as possible, every set passed on is complete to every part, so that no time may be lost in assembly.

Assembly lines are long and well

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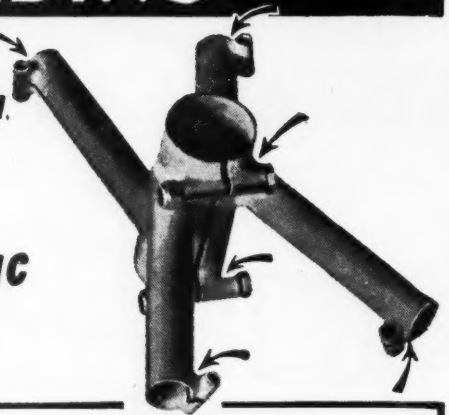

PROBLEM

Fabrication of this intricate steel aircraft tubular assembly with high temperature fusion welding was impractical because the high heat resulted in distortion and softening of the metal. Additional time required for machining the joints rendered the process too costly.

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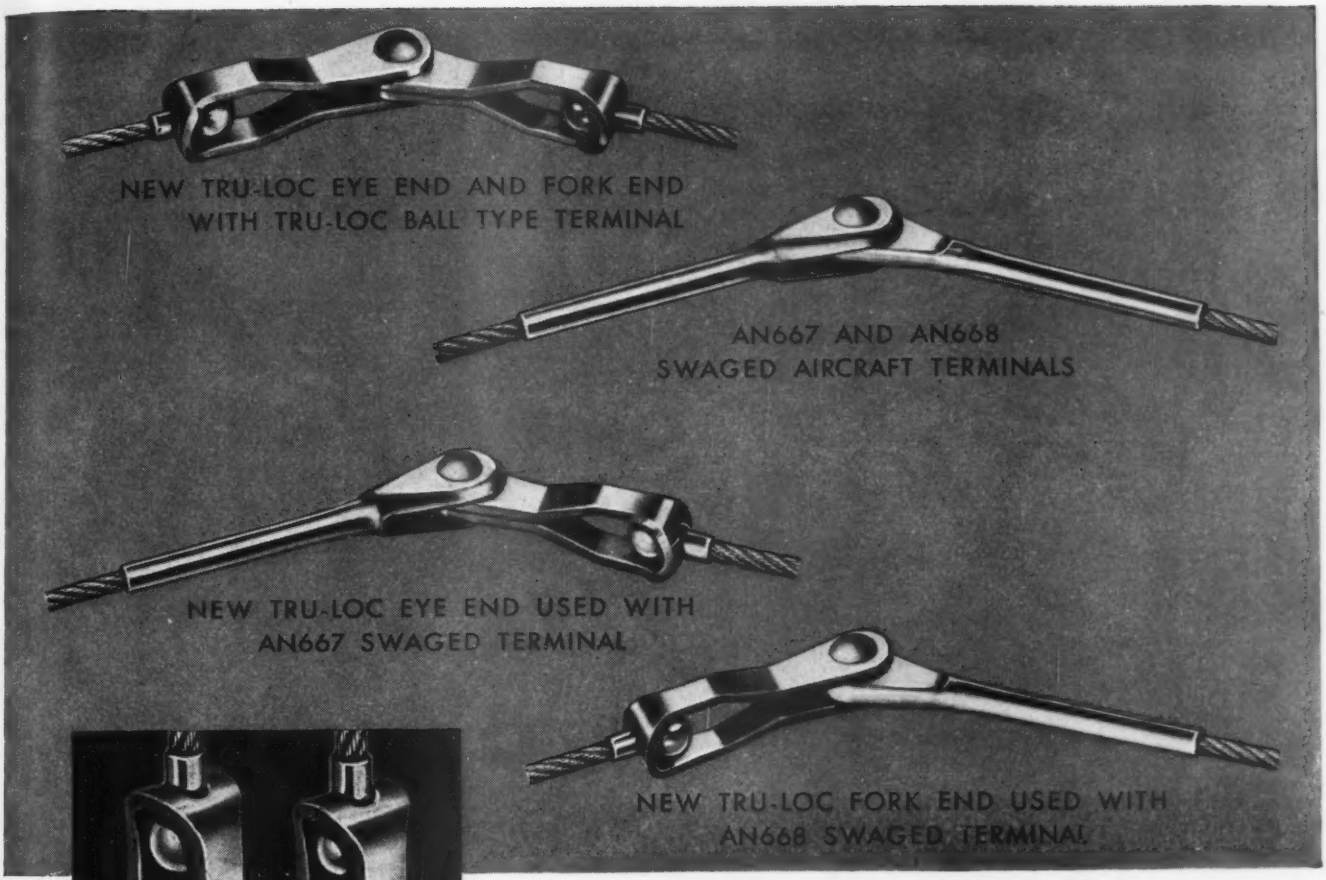
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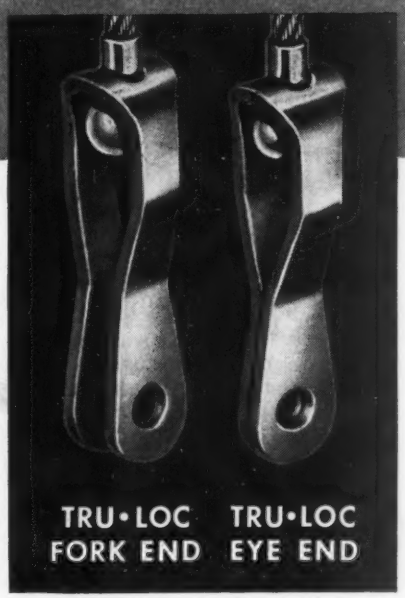
AN667 SWAGED TERMINAL
NEW TRU-LOC FORK END USED WITH
AN668 SWAGED TERMINAL



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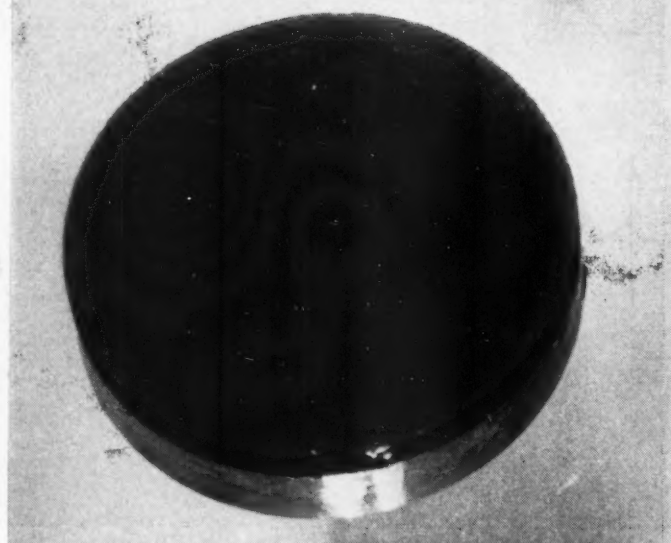
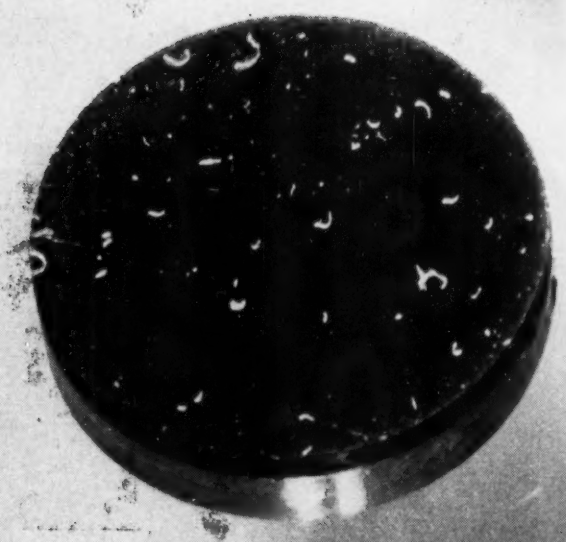
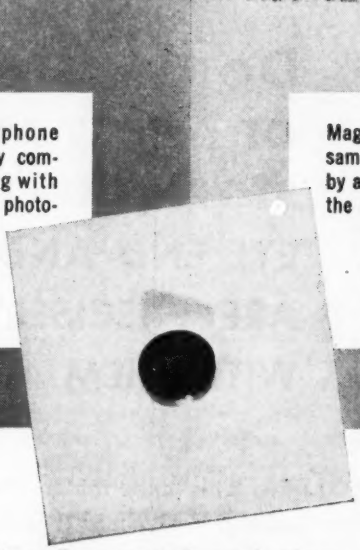


Unretouched photograph of microphone carbon electrode as used in military communication devices, after cleaning with Celanese lint-free wipe cloth. These photographs show why the manufacturer of this military communication equipment has adopted Celanese Assembly Line Fabric for wipe cloths.



Magnified approximately seven times, the same electrode is shown after being wiped by an ordinary cloth. Because lint will affect the electrical characteristics and uniformity of this precision part, it is particularly important that the electrode be lint-free in assembly...Center below, photograph of electrode actual size.



Comparative tests in cleaning metal and glass surfaces and lenses are the reason why manufacturers of communication devices, precision instruments and optical equipment are increasingly adopting lint-free Celanese* Assembly Line† fabrics for uniforms, hats, gloves and wipe and bench cloths.

For further information, consult our Precision Fabrics Division, Dept. "FF"

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spaced, and each runs between two lines of benches. One line is devoted to *Cheetahs,* one to Jacobs, one to Pratt & Whitneys, and one to Wrights and more occasional visitors. Lines are divided into five sections consisting of rear engine section, power, front section, cylinders and pistons, and accessories and final wiring, with separate inspection for each group as completed.

Two engine dollies to carry finished engines to the test houses have been built in the shop. Each accommodates two engines and is equipped with detachable mounts which are assembled with the engine. The whole unit is then fastened to the dolly and transferred to the test stands, of which there are two for *Cheetahs,* two for Jacobs, and two for *Hornets* and *Wasps.* Adaptor mounts can be attached for various types. The test houses are of modern, soundproof brick construction.

After test runs, engines come back to the shop for final inspection and servicing. When approved by RAF or RCAF, they are crated and loaded into railroad cars which run beside the shop on a spur track. *Cheetahs* and Jacobs are close enough in dimensions to enable shipping in identical crates, which always include a mounting plate for each make. In this way crates can be interchanged according to need.

Perhaps the greatest experience and skill required in the plant is in sorting out usable parts from crashed trainers, which sometimes arrive as little more than a heap of junk. With considerable variety of types, knowledge of how much can be saved and reworked is very important to efficient and economical maintenance of stores. The wood, metal, and fabric shops can remake almost anything, and with the complete welding facilities, propeller shop, and instrument-accessories sections, a complete aircraft can be rebuilt from what initially appears to be a dead loss.

The propeller shop should not be passed without some mention, for it services propellers of all types from the large Hamilton Standards used on B-25's to small two-blade wood airscrews of the trainers. Many of the latter have been saved from scrapping, when the hub plate has slightly worn into the wood, by application of a plywood inlay under the plate, giving a new solid seat.

Assembly of rebuilt aircraft is handled as much as possible according to factory subassembly procedure. Fuselage equipment is installed before the wings go on, engines are subassembled with starters and generators, then fastened to mounts. The *Harvard* wing center section subassembly is completed with tanks and landing gear before being attached to the fuselage. Wings are assembled and controls balanced before attachment.

In major assembly, specialized crews were tried in handling each section of the work, but it was found that more supervision was required than if one crew were trained to carry through the whole process on one ship. With this method, greater familiarity with individual requirements and state of progress, with less conflict of group interests, has been achieved. Lists posted on each plane give crew names, man in charge, state of completion, and parts on request with dates of same, so that all delays may be checked. Keen competition between crews keeps the planes rolling out.

The service rendered to the whole Allied effort—Canadian, British, and U.S.—has been creditable, and the United States Army has been quick to acknowledge it.

"Junior CAP" Aids Young

(*Continued from page* 239)

This resulted in giving students in the Tennessee schools a head start in aeronautics and enabled them to turn out a higher percentage of true Navy models than any other state. It also gave

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teachers a preliminary glimmering into the bright fields of teachnig aviation subjects and gave them a better perspective by which to pick cadets for the CAP.

The first cadet squadron in Tennessee was organized in Nashville. Since the Nashville Group is large, it was thought best to let pre-flight teachers choose the students from the higher ranking grades. Each squadron took a school to sponsor and a corresponding number of cadets were chosen. The Second Squadron (451-2) for instance with 40 members, sponsored 40 cadets in Hillsboro's high school. Those 40 cadets were then taken over and instructed by the squadron.

This method facilitates drilling and class work, which is done separately in each Nashville CAP Squadron, with the exception of a group meeting and review once a month at the local airport. Each cadet squadron meets with its sponsoring squadron for classroom work and drill; thus a minimum in time, organizational red tape, and gas-rationed travel is being maintained.

The only difference besides age between the cadets and regular CAP'ers is a slight change in uniform and the fact that, although they will have contacts with real aircraft and operation of planes, the cadets will not receive actual flight instruction.

The uniform consists of a plain khaki shirt without the CAP red shoulder loops, khaki trousers for boys, skirts for girls, black tie, belt with a plain buckle, tan socks, plain tan shoes, and overseas cap prescribed for CAP. Insignia are: Sleeve emblems with the tri-bladed propeller in the triangle, but with the "U.S." of the CAP omitted and the word, "Cadet", added below the circle and worn on the left sleeve ½ in. below the shoulder seam; CAPC silver cut-out letters worn just above the right shirt pocket; and a cap emblem of a red two-bladed propeller with white wings on a blue cloth disk 1¼ in. in diameter.

The Minnesota Wing was the first to report formation of a CAPC Squadron. Only a week after directives and application blanks were issued from National Headquarters, last October, 39 students of pre-flight classes in Central High School, Minneapolis, were sworn in by CAP Squadron 711-4 and immediately went into training at the Minneapolis Armory.

Almost simultaneously, neighboring St. Paul's CAP Squadron 711-3, which has 75 members, swore in 22 cadets under Lt. J. E. McGuiggan, commanding officer of the squadron. Immediately they were launched into a course of study which is being emulated across the nation.

In the first aid class they studied anatomy, using human skulls and skele-

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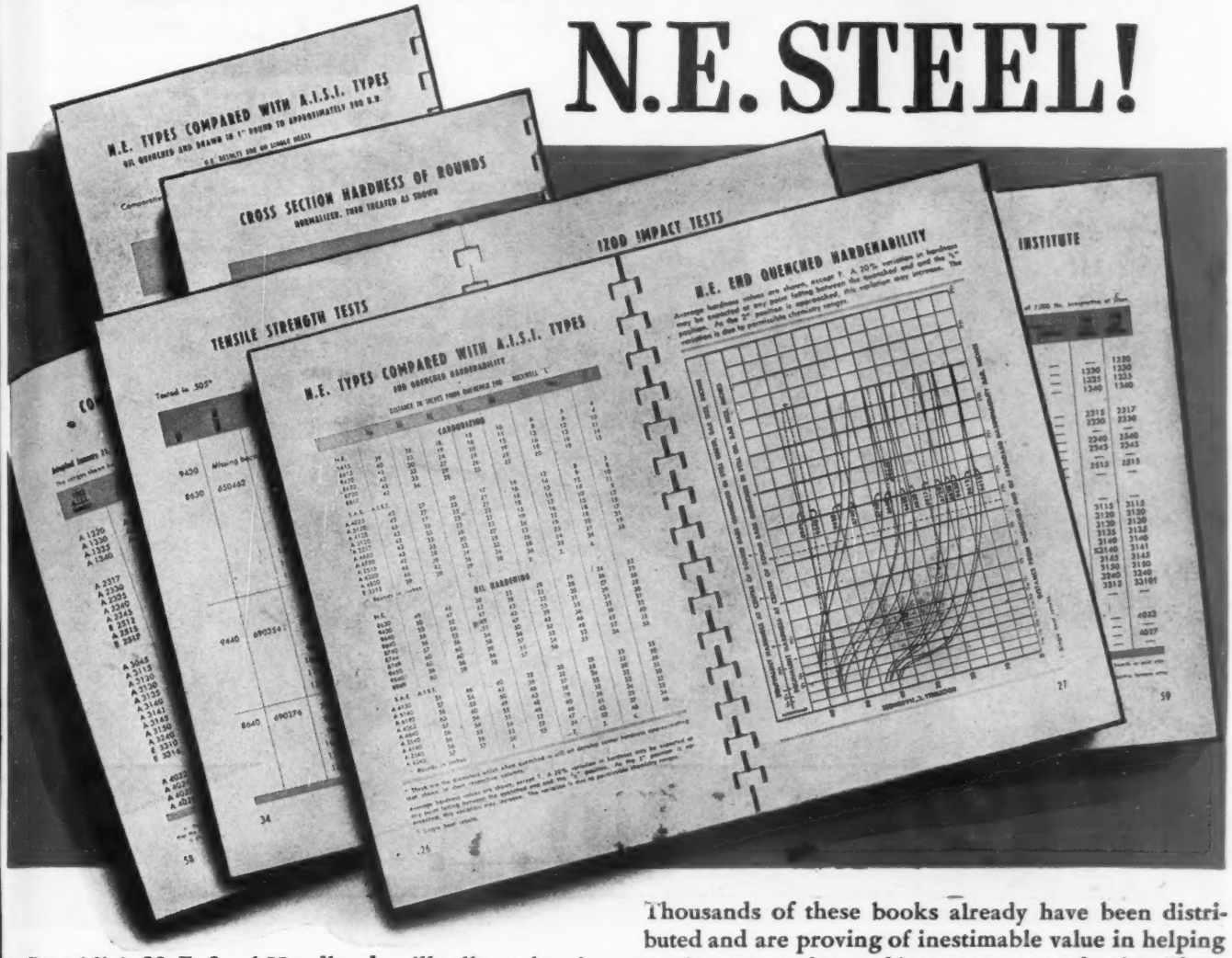
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tons. They learned to recognize shock and how to treat it. They found how *not* to move an injured person. They wrapped bandages, took temperatures, and made tourniquets.

In aerodynamics they went to airports and studied aircraft, learning to apply their recently acquired vocabulary of such terms as, "lift, drag, longitudinal axis, lateral stability, and yawing".

They quickly learned that meteorology is not, as one girl cadet thought, "a study of shooting stars". Trips to airport weather stations have included the study of day-old weather maps, instruction in reading barographs and anemometers, and forecasting experience from studying the movements of low and high pressure areas.

One CAP meteorology instructor said, "I've never seen any group as excited as my cadets were when their first weather prediction almost came true. We based our predictions on a day-old map by the movement of low pressure areas. We then checked them against actual reports."

Young minds are quick to grasp the principles of avigation. Flyleafs of their math and French books began to be cluttered with geometric figures and such terms as "true course . . . magnetic course . . . angle of drift," and the like. Recess and After-school conversations became flavored with such subject matters as: "Hey, Joe, I hit Memphis right on the nose yesterday."

Such flights are all imaginary—from Nashville to Memphis, or from St. Paul to Winona,—but in this fashion the cadets are preparing for the airways of tomorrow.

In aircraft and engine mechanics courses, cadets studied torn down engines. In code practice they learned the "dit-dah" language of airways communications.

The purpose of all this training is not to make pilots of everyone, but to give outstanding boys and girls throughout the nation an opportunity to learn about the third dimension medium which is changing, and will continue to vitally influence, the geographical, political, and scientific aspects of civilization.

This training has, however, a more immediate value. Most of the boys and many of the girls will graduate from high school into some branch of the armed forces. If it is to be some branch of the air services, they will have an incalculably valuable background. And wherever it is, their military training will be in their favor. Already hundreds of the cadets have gone into service and have won rapid promotions to non-commissioned grades because of their CAP background.

Now that CAP has become a direct auxiliary of the Army Air Forces, the pre-training value of the CAPC program can be further developed. Cadet units totaling well upwards of 20,000 members are rapidly expanding in all parts of the country.

Review of Patents

(*Continued from page* 194)

Compensating Device has been designed for augmenting or decreasing an input value by any predetermined variable or fixed amount and for transmitting corrected value to an output. Unit is described as compensating automatically for deflection of a radio wave from its true bearing to deliver an output the value of which is proportional to value of true bearing of wave.—2,316,004, filed July 17, 1941, issued Apr. 6, 1943, E. J. Kuebert and H. F. Penfold, assignors to Fairchild Aviation Corp.

Airplane Engine Mount. Unit is for mounting in-line, flat, or V engines in airplanes, particularly a flat opposed-cylinder engine in which axes of cylinders are arranged in a horizontal plane.—2,316,077, filed Apr. 12, 1941, issued Apr. 6, 1943, O. C. Koppen, assignor to General Aircraft Corp.

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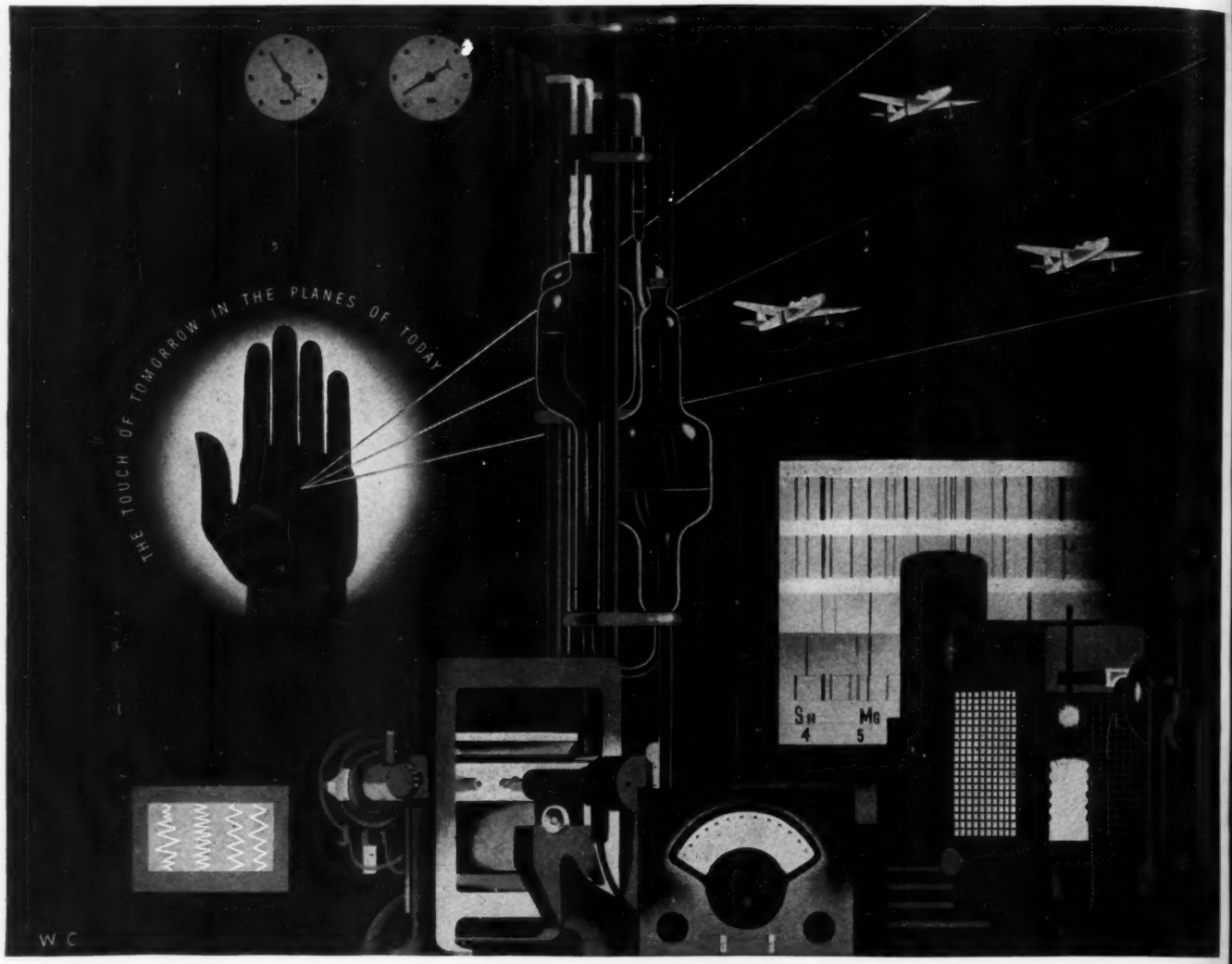

Organizing Atoms for a Better Aircraft Engine

A visitor at the Ranger plant once remarked: "Scratch a Ranger engineer and you'll find a scientist!" In creating the Ranger in-line, air-cooled aircraft engine, Ranger engineers began by concerning themselves with the very atoms of which its metal alloys are composed. They made use of scientific instruments and techniques unexcelled anywhere in the world in scope and precision. And the same advanced metallurgical and chemical laboratory facilities are today guarding the quality of Ranger materials in the rush of war-time production. Spectroscopic, chemical and X-ray analyses of materials and finished parts are as much a part of Ranger production as milling machines, turret lathes and grinders.

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While thousands of Ranger engines are turning in a remarkable record in the planes of the United Nations, Ranger engineers persist in researches which will make even more readable news tomorrow . . . except in Axis newspapers.

"ON THE BEAM"

"The independence and liberty you possess are the work of joint councils and joint efforts, of common dangers, sufferings and successes."

—Geo. Washington's Farewell Address

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Division of Fairchild Engine and Airplane Corporation • Farmingdale, Long Island

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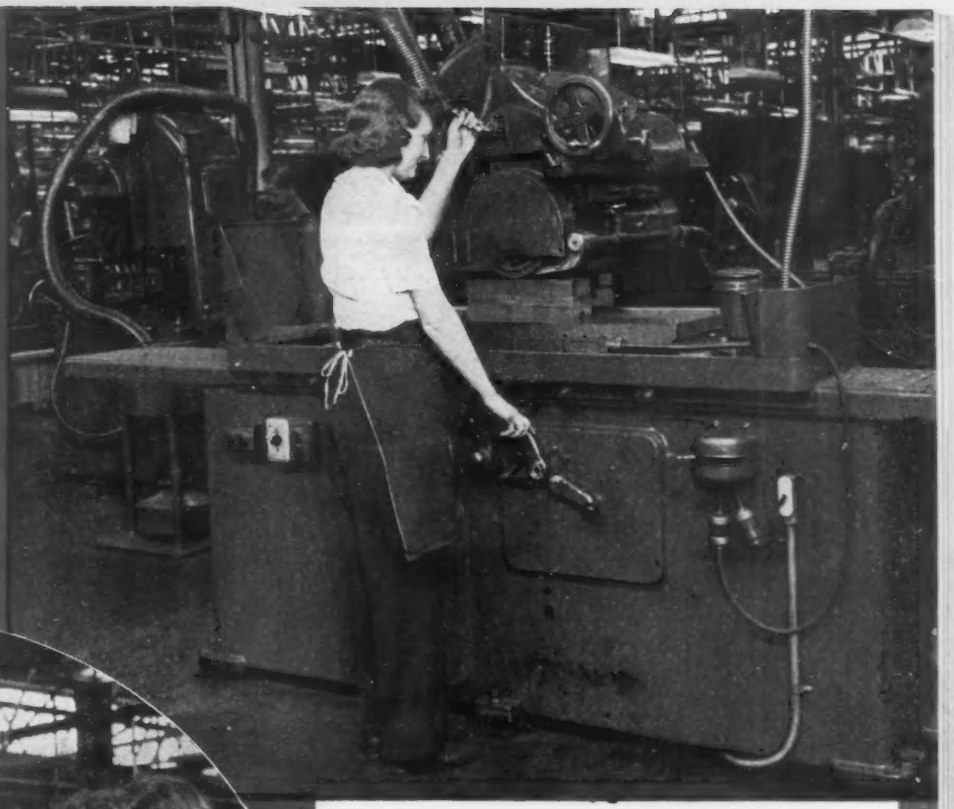

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a full line of hydraulic surface grinding machines from the small tool room grinder 6" x 18" to the larger C types 36" x 220".

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Women are rapidly filling the vital spots left by loyal men who have joined the various branches of our fighting services.

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SPRINGFIELD, OHIO

WELDON AIRCRAFT FLUID METERING PUMPS (TO AN SPECIFICATIONS)

CONDENSED AN SPECIFICATIONS	PUMP MODEL NO: 100	101	102	103	200	201	202	203	300	301
Number of Outlet Ports:▲	2	2	2	2	1	1	1	1	1	1
Motor°* Speed: Constant (C) Variable (V)	V	C	V	C	V	C	V	C	C	V
DELIVERY: in Gallons per Port per Hour — MAX. (Low Speed)	½		1		½		1			2
MIN. (High Speed)	2		4		2		4			8
MIN. (Const. Speed)		4		2		4		2	8	
EQUIPMENT FURNISHED: Rheostat (R), Filter (F)	R, F.	F.	R, F.	F.	R, F.	F.	R, F.	F.	F.	R, F.

°The motor is a 24 volt, D.C., fractional horse-power, explosion proof, series-wound, aircraft type motor—built to Air Force specifications

*Electrical Connectors that can be furnished with any WELDON AIRCRAFT FLUID METERING PUMPS:

AN No.	THREAD	CONTACT WIRE
AN-3102-10S-2P (Government Specification)	⅝-24	# 16
AN-3102-12S-4P	¾-20	# 16
AN-3102-12-5P	¾-20	# 12

▲Inlet and Outlet Port Threads Optional:

⅞-20 N. F.-3 AND 10050, or ⅛" N. P. T.

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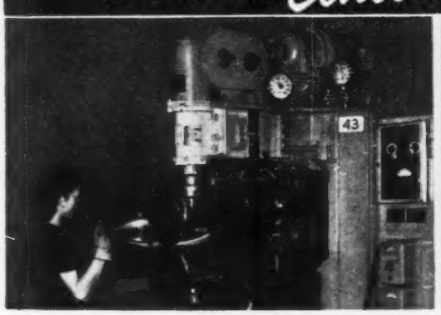

E-Z Code Labels Help Green Welders Make Spots to Meet Exact Specifications

By playing the important circuit-identifying role in instruments that measure power-values, E-Z Code Labels are helping production engineers meet the exacting new voltage, pressure and time requirements for spot welding. These gauges and dials enable green welders to make perfect spots by setting machines from charts.

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E-Z Code LABELS
QUICK-EASY TO APPLY AND READ

Buick Machining of Cylinder Heads

(*Continued from page* 176)

After all filing and polishing are completed, the heads are degreased and undergo final inspection which, of course, is in addition to the gaging done after most of the foregoing precision machining operations. Plug gages are applied to most of the holes, a majority of which are held within either plus or minus 0.001 or 0.0005 in. of the specified dimensions. As a rule, this is done in Buick practice, even when drawings permit of wider limits, since the extra care required is not excessive and in some cases "buildup" (cumulative) errors occur otherwise, which may give trouble in assembly, whereas it is avoided by the practice followed. Great care is also taken to assure proper location surfaces at the start of machining.

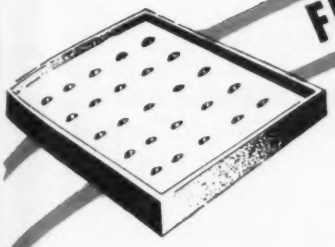
Since several machining and other operations have to be performed on various surfaces after the cylinder head is assembled with the cylinder barrel and assembly operations involve shrink fits, the assembly is done in a production department, not as a part of the final engine assembly. As a preliminary to making the shrink fits, cylinder heads are heated for one hour as they are carried on a conveyor through a Greenwich intermittent oven.

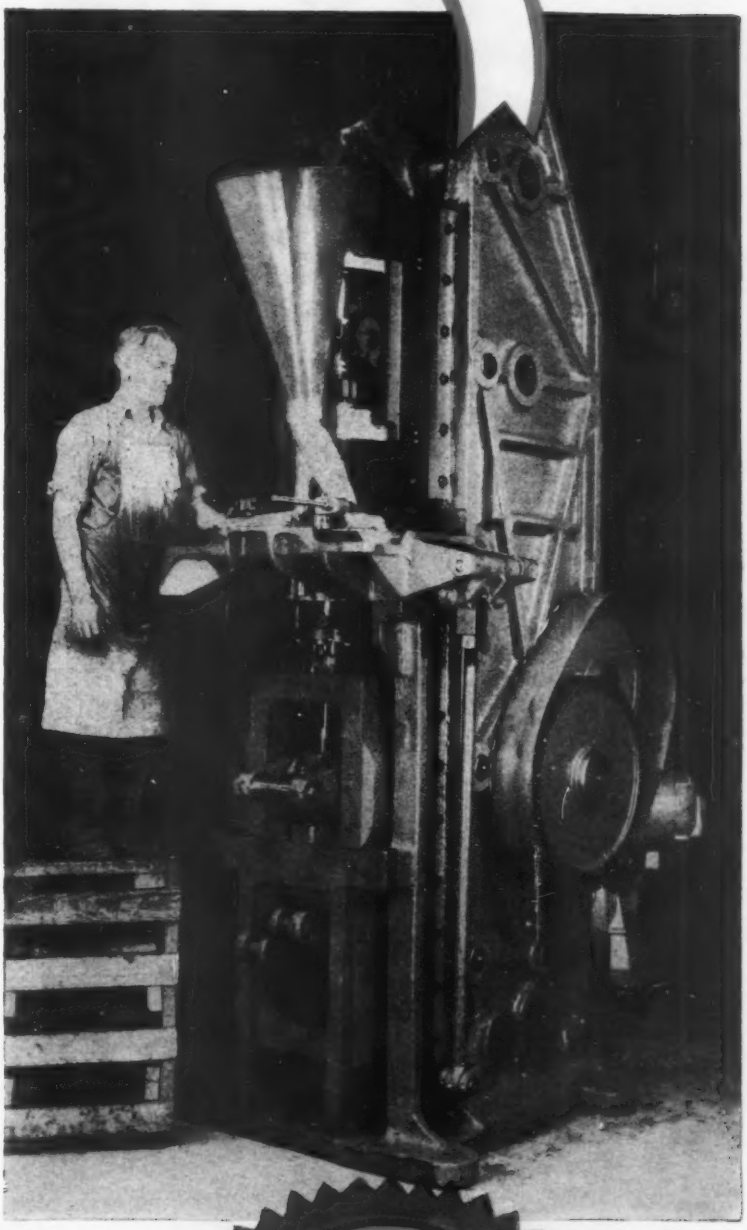
Before discharge from the oven, the heads reach a temperature of 550 deg. F. and, of course, have to be handled with gloves into a clamp fixture which holds them in required position. Small parts to be placed in the heated head are previously cooled in Frigidaire coolers to −32 deg. F. before positioning.

Handling of these parts, and their assembly into the head are done by two men working as a team. The small parts include two valve-seat rings, which are the first parts applied, four valve rocker shaft bushings, two spark-plug bushings, and two scavenger pipe couplings, the last four being screwed into the tapped holes provided. Valve seat and rocker shaft bushing are pressed or driven into place on special mandrels provided for this purpose, and special tools are also used for applying screwed bushings. Feelers or other gages are applied to make sure that these parts are driven home so as to assume the position intended.

Insertion of the cylinder barrel follows the placing of the valve seats. It is screwed in by hand, since the expanded barrel affords ample thread clearance to enable it to be screwed home without tools, even though the barrel is not cooled below room temperature. In cooling, the head is understood to shrink about 0.021 in., or a sufficient amount to insure fits which

FROM PILLS TO AIRPLANE PARTS





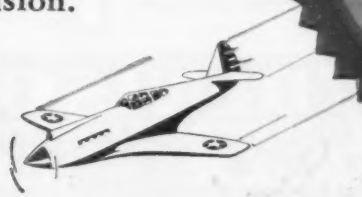
THIS huge Kux automatic powdered metal and ceramic press weighs 13,500 pounds, stands 11 feet high, and is doing a "bang out" job of producing everything from medical and vitamin pills to airplane parts for our Armed Forces.

Timken Graphitic Steel is helping Kux presses do an exceptional wartime job. Their cam inserts, cam rollers, roller pins, dies, punches, and core rods are made of Timken Graphitic Steel. The Kux Machine Company reports that Graphitic dies provide exceptional life, have excellent hardening properties and easy machinability.

"In nearly two years of service, none of the Graphitic press parts have required replacement," say Kux engineers.

Would you like to know more about this free-machining, long-wearing tool and die steel? A request on your company letterhead will bring you the latest edition of the Graphitic Steel Booklet. The Timken Roller Bearing Company, Canton, Ohio. Steel and Tube Division.

The one test for every decision-- Will it help to win the war?



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are tight and which, in consequence, afford the required rate of heat transfer in subsequent service.

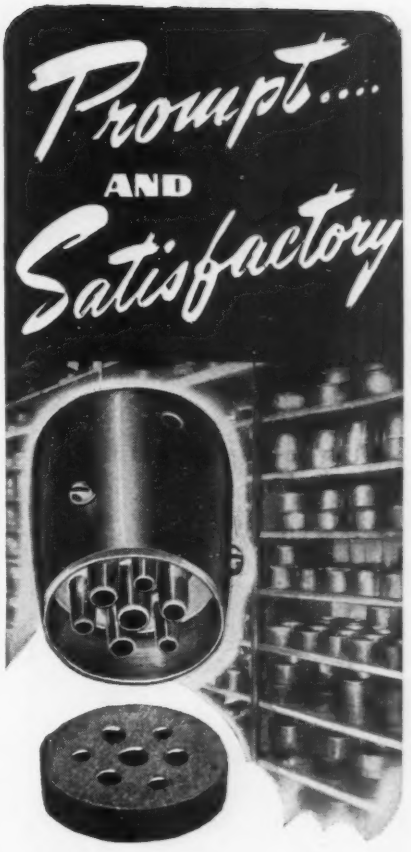
After the foregoing assembly is completed, it is transferred to a simple bench fixture which holds it in a convenient position for attaching the small copper scavenger manifold or U-shaped pipe, the ends of which are inserted into two couplings previously inserted into the head. A clamping fixture holds this pipe in correct position for brazing (Fig. 6). The latter is done, after applying Handy flux, with a silver brazing alloy called Easy-Flo, by means of a single-tip oxygen-gas flame. A small clip is similarly brazed to the center of the short manifold.

Certain machining operations are performed on the assembly after the foregoing work is completed, but only those on the head, as distinct from the barrel, are detailed here. Before these are done, however, the assembly is washed in clear hot water and is then degreased in trichlorethylene. All machined surfaces on the exterior which are involved in subsequent fits are then masked, after which the remaining exterior surfaces are subjected to sand blasting in a special twelve-station Pangborn rotary machine. This blasting takes place in a closed space while the assembly is held in a rotating fixture on which it is carried through the machine circuit.

The sand is thrown by a blast of air from a line at 100-psi. pressure, and the fixtures are so arranged that all inside faces and the exterior of the barrel skirt below the bolting flange are kept out of contact with the sand. All handling is done with gloves, and when the blasted assemblies issue from the machine they are shifted at once to a special metal-spray machine designed to apply a coating of molten aluminum to the entire blasted surface.

This aluminum coating process is done in a special automatic machine in which the assemblies are mounted on holders in vertical position. The assemblies rotate about the cylinder axis as they are advanced from station to station on the circular table of the machine. In making this circuit, the cylinders pass through the spray from a series of guns at different levels and so placed that almost the entire surface to be coated receives the metal spray. The guns are fed by air pressure with aluminum wire containing 1 percent of zinc, and this is converted into a molten spray by the oxygen-acetylene flame provided in each gun.

At two of the stations the guns are aimed by hand so as to touch up any surfaces not properly coated by the automatic guns at preceding stations. The coating is applied to the exterior of the steel cylinder barrel and its fins above the bottom of the bolt flange, as



IT IS gratifying to obtain prompt shipment of materials and parts! Even more so, if they exactly suit your purpose. This double achievement is routine occurrence at plants where Booth "prescription" felts — precision die-cut to specifications — are overcoming critical material shortages. Aircraft and other vital war industries thus bypass many a production problem!

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well as to the fins and other exposed surfaces of the head assembly. The mechanical bond coating is adherent and considerably increases heat-transfer efficiency while providing good resistance to corrosion.

Next, the assembly is returned to a machining line on which several hand and power machining operations are performed. These include rolling-in (with a hand tool) the exhaust valve seat, and reaming the intake and exhaust valve guide bushings on a hydraulically operated Leland-Gifford drill press. Then the intake valve seat is ground, using a Hall eccentric grinder in which the tool is driven by a flexible shaft. The tool holder pilots in the valve stem guide bushing, but the wheel is given an eccentric motion in reference to the valve stem axis and generates a true seat in the grinding process. Hand tools are next used to reface the sparkplug bushings and to retap the threads.

Exhaust valve seats are ground on a Waddell machine in which the assembly is held in correct angular position head downward (Fig. 7). The grinding wheel and its spindle are inserted from above after the cylinder is in place and, besides being rotated about the axis, are given an eccentric motion during which the seat is accurately ground with the grinding wheel touching only one point at any given instant. A diamond is used to dress the wheel and to maintain a sharp edge after grinding four or five seats.

A kerosene spray is then applied to remove all grit from the valve grinding operations, after which dummy valves and plugs are inserted and the assembly is placed in an air-clamping fixture. Water is admitted to the cylinder under main pressure, and its pressure is raised by a hand pump to 500 psi. to make sure that there are no leaks at valve seats or plugs. After testing the oil scavenger line also, all small holes for studs are hand tapped, removing about 0.016 in. of metal left in prior tapping operations. A Kellerflex machine with a rotary file is then used to cut certain spots on the rocker box edges for rocker arm clearance.

Go and no-go thread plug gages are next used to check all threaded holes, and a torque wrench is applied to see that exhaust flange nuts are properly tightened. All studs are then inserted and the push-rod gland hole is hand tapped, after which a hand tool is used to screw in the gland. A deflector bushing is also inserted.

Ths completes all machining and assembly work on the head. Then the cylinder barrel receives its final grinding and is magnafluxed, and the assembly is degreased and passes through final inspection. As will be seen, extreme care is taken in the whole job,

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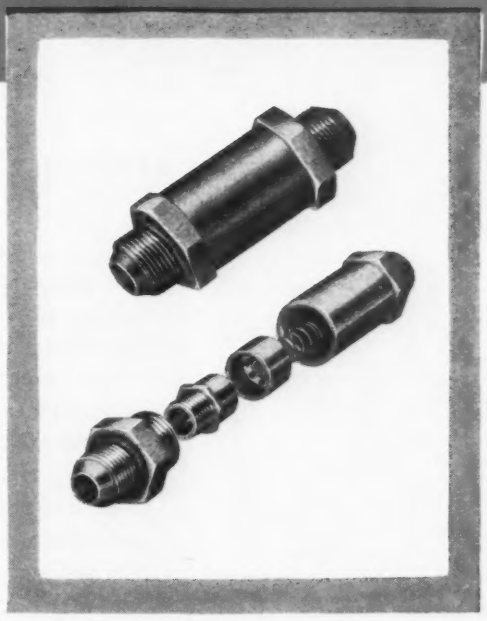

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Template Reproduction Simplified

(*Continued from page* 181)

blank metal sheet, which eventually becomes the duplicate template. Transfer may also be made to any other suitable materials, such as plywood or masonite, by first spraying them with a single coat of Transphoto paint. When it is removed, the duplicate sheet then has a positive image of the original layout in the form of dark lines which have been formed by a deposit of silver from the film image, the final transfer actually being a silver plating.

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Piper Makes Low-Wing Trainer

(*Continued from page* 233)

aileron are mounted on an auxiliary rear spar. In addition to the landing gear and retracting mechanism, the center section carries two stainless steel fuel tanks with total capacity of 40 gal. Wings are covered with $\frac{3}{32}$-in. mahogany plywood which, in turn, is fabric covered to facilitate standard finishing procedures and to protect the wood surface.

Wing foil is USA 35B15 at the root and 35B10 at theoretical tip (as compared with USA 35B basic section used in Piper J-3 trainer) to retain high lift but yet give higher speed. Taper ratio is 2 to 1, with 6 deg. dihedral and sufficient washout to avoid unfavorable stall characteristics.

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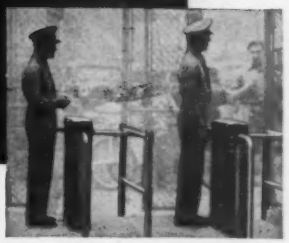

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Light-colored floors made with Atlas *White* portland cement, instead of gray portland cement or still darker materials, reflect more light on vertical work surfaces as well as on under surfaces. They improve seeing . . . speed production . . . reduce accidents. Installations for Boeing, Consolidated, Douglas, North American, and others prove this.

Light measurements made by General Electric in the Consolidated Aircraft Plant at Fort Worth show that a *white*-cement floor, compared with a gray-cement floor in the same plant—

- ▶ **increases illumination on vertical surfaces by 20%;**
- ▶ **increases by 61% the illumination on underside surfaces;**
- ▶ **reduces shadows and dark areas;**
- ▶ **reduces contrasts . . makes seeing easier, more comfortable, and more efficient.**

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AV-F-10

ATLAS WHITE CEMENT
For Light-Reflecting Floors

has an unusually wide spread of 100 in. and, in production models, will be electrically operated. Visual and audible signals are provided in both cockpits.

Controls and instruments are identically located in both cockpits, and the craft is said to fly solo from either position with equal facility. Instruments include: Tachometer, oil temperature gage, fuel and oil pressure gages, compass, altimeter, airspeed indicator, rate of climb indicator, bank and turn indicator, clock, fuel selector valve, flap control, parking brake, landing gear retracting mechanism control, wobble pump, starter, carburetor heat, and cabin heat.

Front tachometer also has an odometer which, based on average r.p.m. through all operations, clocks the operating time. Navigation lights are standard equipment and, for night flying, provision is made for landing lights and flares. For instrument training, an auxiliary panel can be installed over the rear panel, with attachment to the turnover structure.

Designer Dave Long, himself a CPTP operator, has considered pilot comfort, providing adjustable seats and rudder pedals. Visibility is reported excellent from both cockpits.

"Liberators" By Ford

(*Continued from page* 161)

practice, but the methods used in riveting are typical of Ford ingenuity. Roller conveyors are provided so that an unriveted spar starts at one end and is ready to assemble on a plane at the other end. The conveyors are adjustable for height and are so constructed that they slide sidewise very easily, making it possible for riveters to align a spar readily with the riveting heads in the machine. From nine to eleven rivets are upset at a time, effecting a very important saving in man-hours compared with the old one-rivet-at-a-time method.

The rollers are used as a work bench as well as conveyor line. In between the riveting stations, girls assemble the stiffeners, ream the rivet holes, and put in the rivets. The spar is never removed from the line until it is finished.

When the spar has been drilled and reamed, with side angles clipped to the spar webbing, it is ready to enter a specially-built double-headed automatic riveting machine. It carries two multiple riveting heads—one stationary, the other with a follow up control so that the head moves sidewise as the width of the spar increases. There is also an automatic feed which advances the spar one group of rivets at each squeeze. The operator need only take out the clamps

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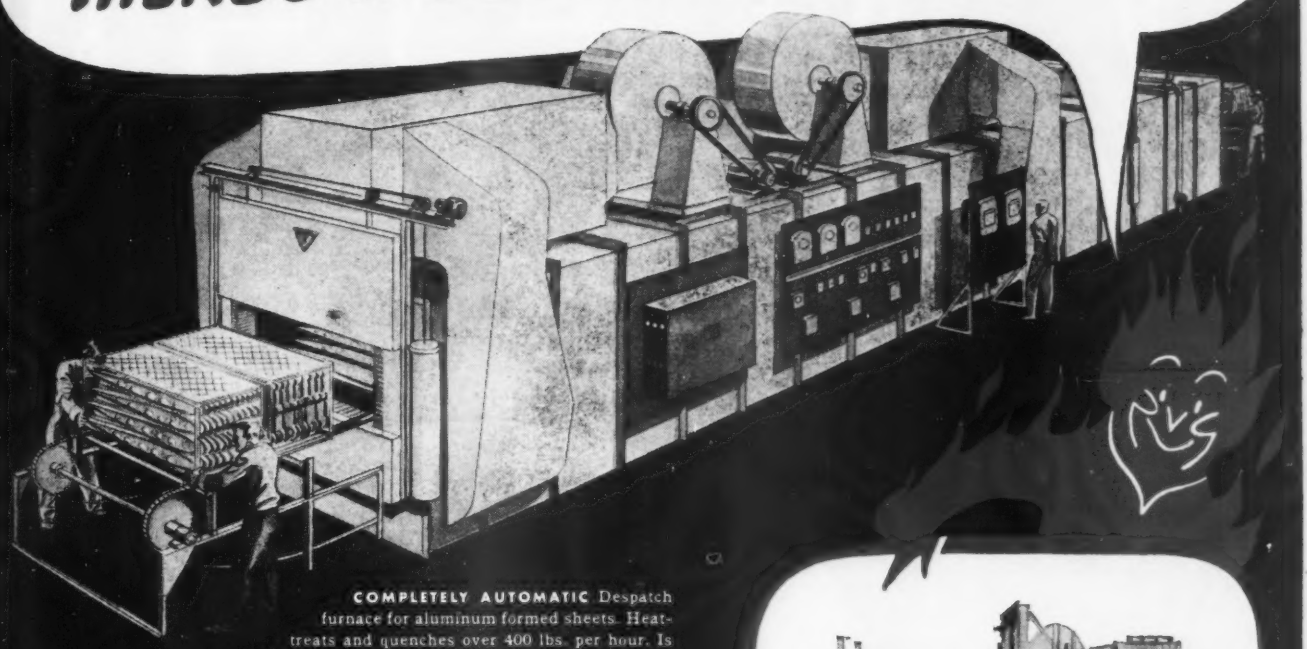


COMPLETELY AUTOMATIC Despatch furnace for aluminum formed sheets. Heat-treats and quenches over 400 lbs. per hour. Is 100% time-cycle controlled: furnace, intermittent conveyor, lift doors and quench. ±5°F. through 40 ft. chamber. Automatically discharges and quick-quenches load. Electric. Special brochure sent on request.

REQUIRING NO HUMAN EFFORT save for loading and unloading, the large "robot-operated" furnace shown above is typical of Despatch's 100% service to aluminum and magnesium fabricators . . . in providing a *complete* line of "built-for-the-job" furnaces.

This big intermittent conveyor-type furnace, though impressive as a single unit, is merely one of the *many* furnaces Despatch offers the light metals industry. Just as this particular furnace is suited to heat-treating aluminum sheets, so other Despatch furnaces are specially adapted to large or small non-ferrous castings, parts, rivets or forgings.

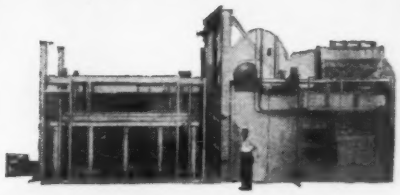
It is this complete coverage of the aluminum-magnesium heat-treating field that has led so many major fabricators to adopt Despatch-built furnaces for *all* their heat-treating jobs.

ALL TYPES ARE PERFORMANCE-TESTED

- **±5° F. heat uniformity** is assured in all models, regardless of type. Forced convection heat exclusively. Allows full use of chamber capacity.
- **Accuracy through heat range** allows strict adherence to processing specifications. Assures highest possible tensile and elongation factors.
- **Fast heat penetration** from special high-volume airflow system speeds heating and avoids dead-spots.

Typical features available include special time-temperature program controls, gas-tight construction, approved safety devices and many other important items.

LET US HELP YOU select the Despatch furnace best suited to your special requirements. Complete engineering service available; no obligation. WRITE FOR BULLETIN 81 describing these furnaces



LARGE CASTINGS are conveniently handled in this Despatch furnace. Electric or gas fired (using indirect radiant tubes). Sizes range upward from 4′ x 3′ x 8′. Very rugged and dependable. Ask for details.

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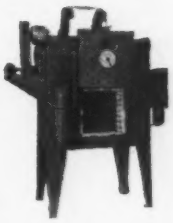

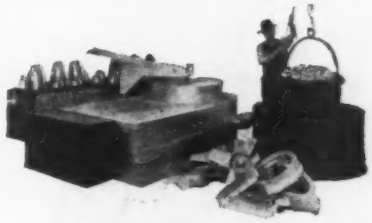

ALUMINUM RIVETS, PARTS, CASTINGS are readily heat-treated in versatile pot-type Despatch furnaces. Electric or gas fired. Standard sizes from 12″ x 8″ (basket diam.-depth) to 60″ x 60″.

***QUICK QUENCH SYSTEMS** (manual or automatic) available for use with all Despatch heat-treating furnaces.*

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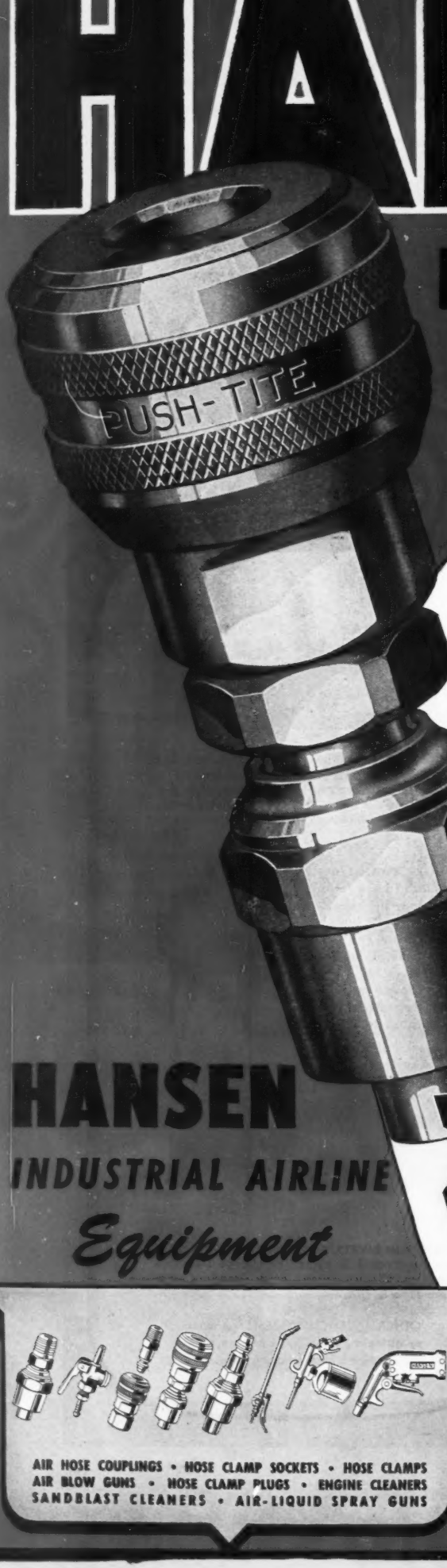

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as they approach the squeezer head. This machine is used for both right and left spars and will handle both the front and rear spars.

From the dual riveter, right and left spars flow down their own assembly lines. At the end of each, bracket forgings are riveted to the finished spar, when the assembly is put on a special fixture. At the mating end there is a milling machine set-up, with the cutter spindle mounted on a table which traverses the end of the spar. Two cuts are taken, a rough and a finish. A locating point, about half the length of the spar, secures it in its proper relation lengthwise to the cutter. The track on which the mill travels determines the proper angle in the face of the brackets.

In the assembly section, which is about $\frac{5}{8}$ mi. long, there are three distinct parallel sections of about the same width, one of which is used for larger subassemblies. In a parallel corridor are built the center wing sections and, in the third, other major subassemblies. The first and last differ in that the first corridor feeds parts transversely into the major assembly lines at about the assembly station where the parts are required. In the second and third corridors the flow of all parts and subassemblies is continuously forward in the direction of final assembly.

In the corridor where parts feed into the assembly line from the side, such subassemblies as wing spars, center wing bulkheads, outer wing leading edges, fuselage parts, fuselage bottom panels, pilot's floors, center wing flaps, trailing edges, stabilizers, empennages, ailerons, and engines may be found. As will be noted, each of these is a more or less complete subassembly in itself. The method of handling these is conventional, except in the case of the pilot's floor, for which there is a "merry-go-round" conveyor. Each fixture is carried on a car which moves intermittently from one station to another until this subassembly is completed.

Lengthwise, the other two corridors are divided into four sections. In the first quarter, the wings are built from parts into a complete structure. In the second quarter two parallel rows of center wing sections go down one corridor, picking up all the smaller parts that help to complete this backbone of the bomber. In the parallel corridor the outer wings, forward and aft fuselages, and tail cones are constructed.

The forward section of the fuselage is divided into six parts: Front and rear top decks, the two sides, bottom, and pilot's floor. The unique part of this job is painting and installing furnishings of the sides while they move along on a conveyor. Until fully equipped they are not joined together with the floor or the top and bottom structures. The intricate equipment that must be

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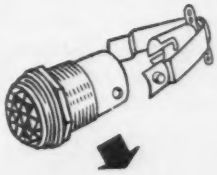

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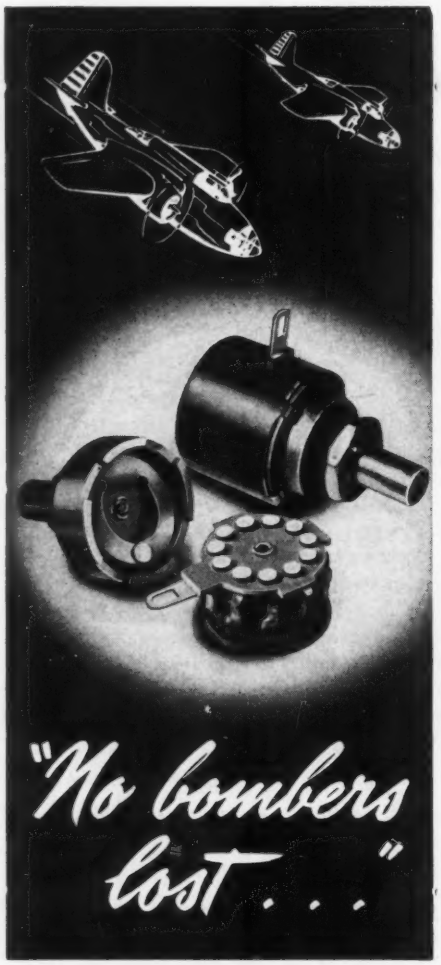

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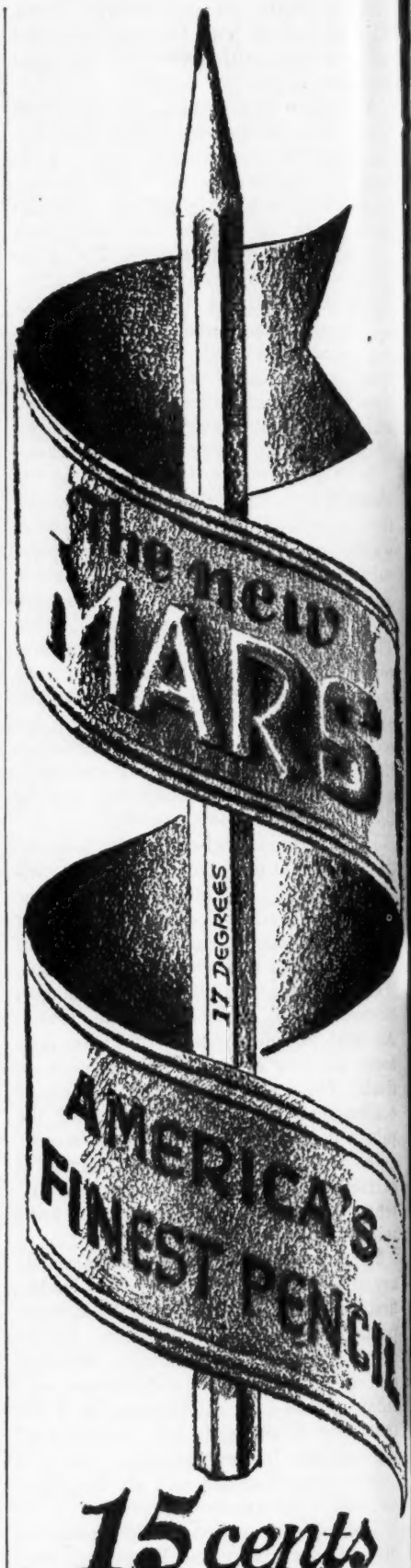
put in at this time goes in much faster when the whole side is open than after the fuselage has been completed and workmen have to crawl inside to put it in place.

At the halfway point in the plant there is a wide cross corridor called the transfer bay section. Overhead there is a 25-ft. high platform or mezzanine gallery on which there are two turntables and a big slat conveyor down the center. This mezzanine extends across the ends of the two assembly bays. Onto it come all major subassemblies, except the center wing section. From this transfer gallery the fore and aft fuselage sections are routed to the center wing assemblies on the final lines. The four primary assembly lines start from this transfer point. The big center wing units are fed to the assembly lines as rapidly as they move forward, and here the Ford-built units get their start. Parts which go to outside assembly plants are gathered on the balcony and loaded into huge trailers developed for transport purposes. Two of them can haul all the parts of a complete bomber (less the engines) to any of the other bomber assembly plants.

Four parallel lines of center wings are moved progressively in the third quarter of the plant, where complete Ford-built *Liberators* are assembled. The first steps in the assembly at this section are made while the center wing is supported by two-wheel trolley plates attached to its ends. These wheels run on rails that carry the center wing at its normal height of about 10 ft. It is supported in level flight position, or at an angle of 3 deg. After the fore and aft sections of the fuselage and the landing gear have been added, the trolley plates are removed and the ship lowered onto its own landing gear.

Between each pair of primary assembly lines, and parallel to them, there is an extension of the mezzanine gallery with a conveyor on which engines and both fore and aft fuselage sections are fed to the assembly line. At each station where this is done a special bridge and traveling crane pick up the correct fuselage section at that point, transfer it right or left, and lower it onto a mating car. On these cars the new section is aligned with the center wing, to which it is to be attached, and then moved into mating position. The engine units are supported by special hoists while the four attaching bolts are slipped into place and nuts run down.

To permit adding the outer wings in the last quarter of the building, it is necessary to change from two parallel lines in each bay to one. Thus there are only two final assembly lines. Dual slat-type floor conveyors permit movement of completed center wing assemblies from either one of the primary



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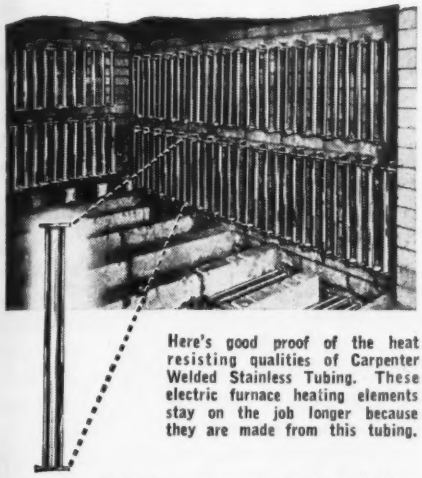

Here's good proof of the heat resisting qualities of Carpenter Welded Stainless Tubing. These electric furnace heating elements stay on the job longer because they are made from this tubing.

Heating elements in electric furnaces such as this... and exhaust collector rings... are made of Carpenter Welded Stainless Tubing — for *positive* protection against heat. And in many applications such as these, the *high strength-weight ratio* of this tubing helps designers save weight and space.

When you need data about Welded Stainless Tubing — or if you could use fabricating assistance—consider Carpenter your general headquarters for helpful information. Ever since the days of Carpenter's pioneering development of this type of tubing, we have had much experience with design and fabricating problems involving its use. Don't hesitate to put that experience to work in your plant.

Use Carpenter's *series of QUICK FACTS bulletins for useful information on the Design of Tubular Parts, Forming, Bending, etc. They can help you take advantage of the properties of Welded Stainless Tubing. A note on your company letterhead will start your set of bulletins on the way, so send for them today.*

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assembly lines to the center of the final assembly bay.

Later the lines turn at right angles and enter the pre-flight area of the final assembly. In this "L", off the main assembly building, is the final inspection section, final paint, Army inspection and, just before leaving the building, a section separated by heavy fireproof doors in which the planes are fueled. Then the big hangar doors at the end of the line are opened and the ship is taken out onto the airport apron for flight tests.

At the turn in the assembly line, there are four doughnut type turntables, each big enough to take a complete ship, located at the point of intersection of each of the final assembly lines. By their use, the planes are given a quarter turn so as to line up properly in the pre-flight area on the plant. By choosing the turntable, the planes may be put on either one of these pre-flight assembly lines. Big doors opposite the ends of the two final lines can be opened to by-pass ships directly onto the airport apron should it be necessary.

With the general plant arrangement in mind, we can turn to the methods used in assembling the various elements. The outer wing is assembled in exactly the same manner as the center wing. Being a smaller unit, the structure of the fixtures can more easily be seen and the methods of fabricating more readily understood.

The first step is to rivet the brackets to the stringers and assemble the latter. This is done on tables with suitable alignment or locating fixtures. When riveted together they are ready to apply in the first wing fixture.

There are two general types of fixtures used for assembling the wings—one for assembling the top skin and the stringers, the other for assembling the spars and bulkheads and then picking up the upper and lower skins. In each type the fixture is designed to locate the parts and hold them securely in correct position until the job is finished.

All these fixtures are rigid, steel and cast iron units mounted on heavy concrete foundations. The first fixture holds the stringers in correct position. Over these the skin is securely held in place by steel straps while it is drilled, counter-sunk, and riveted to the stringers. Rivet holes are back drilled through pre-punched holes in the stringers and reamed at the same time. On center wing and outer wing top skins, these holes are countersunk in the skin, flush rivets installed, and the skin riveted to the stringers. Because of the height of the fixture and wing it would be difficult to work without a ladder for the top or without stooping to reach the lower edge. These fixtures are raised high above the floor to allow the

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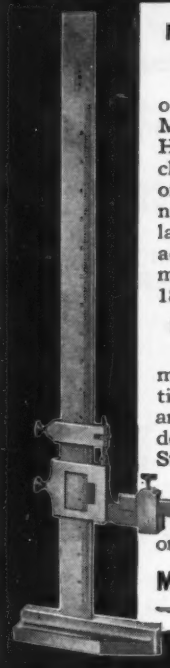

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elevator platforms on each side to drop low enough so that the lower edge of the wing comes at a comfortable working height for the operator. Air and electric outlets are conveniently located all along the base of the fixture.

Outer wing assembly fixtures are provided with a movable top running on rails so it can be moved to one side when a wing is completed. One spar rests on the bed of the fixture, the other is loaded into the movable top member of the fixture while it is displaced. Each end of the fixture has a retractable end plate that accurately secures the ends of the spars and the splice flanges during assembly. End plates, controlled by hand wheels, slide in gibs and are located by index pins. The movable overhead beam is also secured in proper position, by index pins at both ends, while the wing is being assembled.

In the fixture, the bulkheads are assembled first to the spars. There are hinged drill guides attached to the top and bottom of this fixture, used to drill the edges of the spars where the skin is attached. Bulkhead stations are clearly numbered on the overhead beams to guard against assembly mistakes. The bottom skins are then clamped to the spar and bulkhead assembly and drilled. When they have been properly fitted they are removed and the upper skin and stringer assembly applied.

Reason for locating the lower surface skin and stringer assemblies first and drilling the rivet holes where the three sections overlap, is found in the method used at Willow Run in attaching these assemblies to the spars. Because skins and stringers are assembled before they are fastened to the spars, blind spots are formed where "hat type" stringers are used. Also, since the entire top skin and stringer assembly is bolted in place at one time it is necessary to fit the bottom skin sections before the top skin is fastened in place.

The upper skins extend across the chord of the wing, the lower ones run lengthwise of the wing. The transverse arrangement of the bottom skins permits assembling them from the underside of the wing after the upper skin is in place. When the final strip is put on the bottom of the wing, bucking is done through access holes.

When the wing is finished and removed from the fixture by crane it is laid on its side and attached to an overhead conveyor line, where all fittings, aileron, controls, wires, wing tip, and leading edge are attached. One feature of the line is the hump where the wing is lifted high enough to allow work on the bottom side, instead of necessitating turning of the wing as when this work is done on bucks.

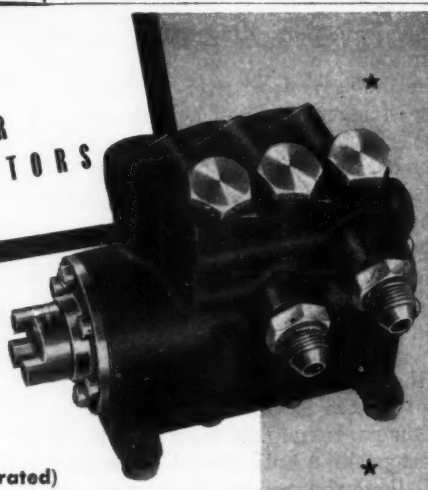
In the center wing section, after the wing leaves the last vertical riveting fixture, it is set up in clean-up stands, where drill guide plates are bolted to each end of the unit. These are used for reaming the bolt holes in the splice angles. These plates are left on the ends of the center wing to protect the splice plates against damage during transfer in and out of the giant Ingersoll machine, which accurately finishes all mating surfaces on the center wing. It has twelve special milling heads that may be operated simultaneously or individually. It finishes all of the vital connecting points. The bed plate of the machine measures 78x18 ft.

While in the Ingersoll, the wing is supported by two pivoted brackets mounted on posts at the base of the machine. When the machining is finished, the wing is lifted out by overhead crane and set on a transfer car. The drill guide plates are removed from its ends and the trolley plates, returned from the primary assembly line, are attached in their place.

Most interesting feature of the primary assembly line is the method of mating fore and aft fuselage units with the center wing section. The nose or fore fuselage consists of six other subassemblies finally brought together in two mating fixtures. In the first, the two side panels are joined to the pilot's

CLARKE

3 CYLINDER HYDRAULIC MOTORS



For driving pumps and for a wide variety of other applications on aircraft, Clarke Aero-Hydraulic Motors are found adaptable because of small dimensions, high power output.

TYPE CO2 (Illustrated)

POWER—Motor develops 1.4 h.p. at 1000 p.s.i. inlet pressure. Weight of only 48 ounces and compact design eliminate needless bulk. *DAMAGE-FREE*—Stalling causes no damage to motor, permitting use of stops to eliminate flap or door overtravel. *DIRECT-REVERSIBLE*—no external bleed line required, obviating additional fittings. *ADAPTABLE*—Available with either flange or foot mounting for all installations. (Foot mounting illustrated)

Design engineers, purchasing agents, and other authorized persons are invited to consult with Clarke engineers concerning hydraulic motors and similar equipment for aircraft.

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ON THE PRODUCTION LINES!

The PRECISION BEARINGS here pictured, together with many others from the comprehensive NORMA-HOFFMANN line, have literally "gone to war" for the Allied Nations.

On the fighting fronts, they are "in the service" in every type of naval craft, from patrol boat to battleship—in bombers, fighters, scout planes, trainers and transports—in guns, tanks, mobile artillery, military transport and supply equipment.

On the production lines, NORMA-HOFFMANN Bearings are in thousands of machines, machine tools, and other vital mill and shop equipment that are turning out ships, armament and indispensable war materials for the American and Allied forces.

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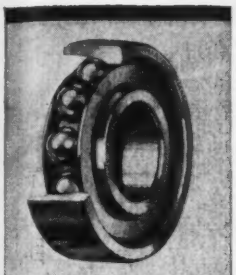
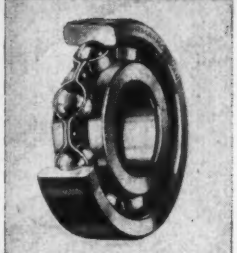
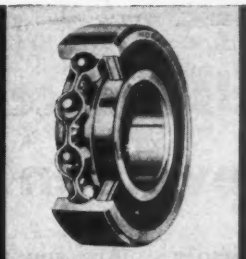

Separable (Magneto) Ball Bearing

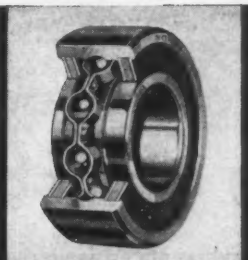
Litro ("CL") Composition Retainer Ball Bearing


Single Row Ball Bearing

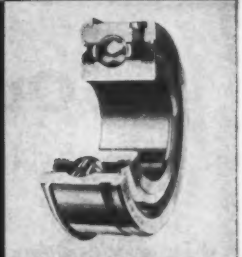
Double Row Self-Aligning Ball Bearing

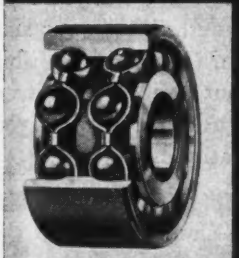
Shielded Type Single Row Ball Bearing

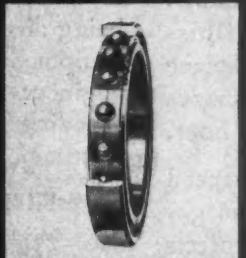

Single Felt Seal Ball Bearing

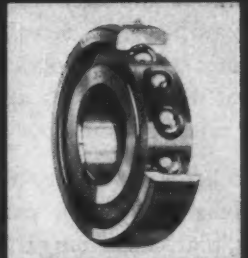

Double Felt Seal Ball Bearing

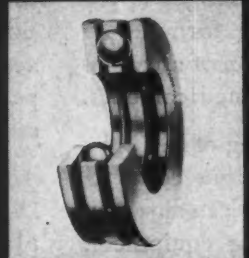
9000 Series (Feltless) Sealed Ball Bearing


"Cartridge" Fully Sealed, Refillable Type Ball Bearing

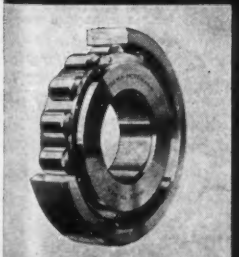

Double Row Ball Bearing

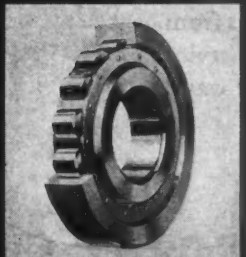

Extra Light Type Ball Bearing

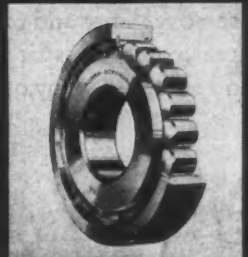

Angular Contact Ball Bearing


Extra Light Single Direction Ball Thrust Bearing

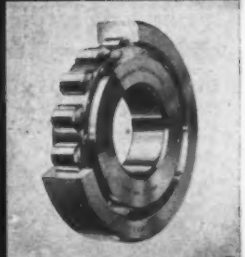
Single Direction Ball Thrust Bearing


Standard Cylindrical Roller Bearing


Type "E" Cylindrical Roller Bearing

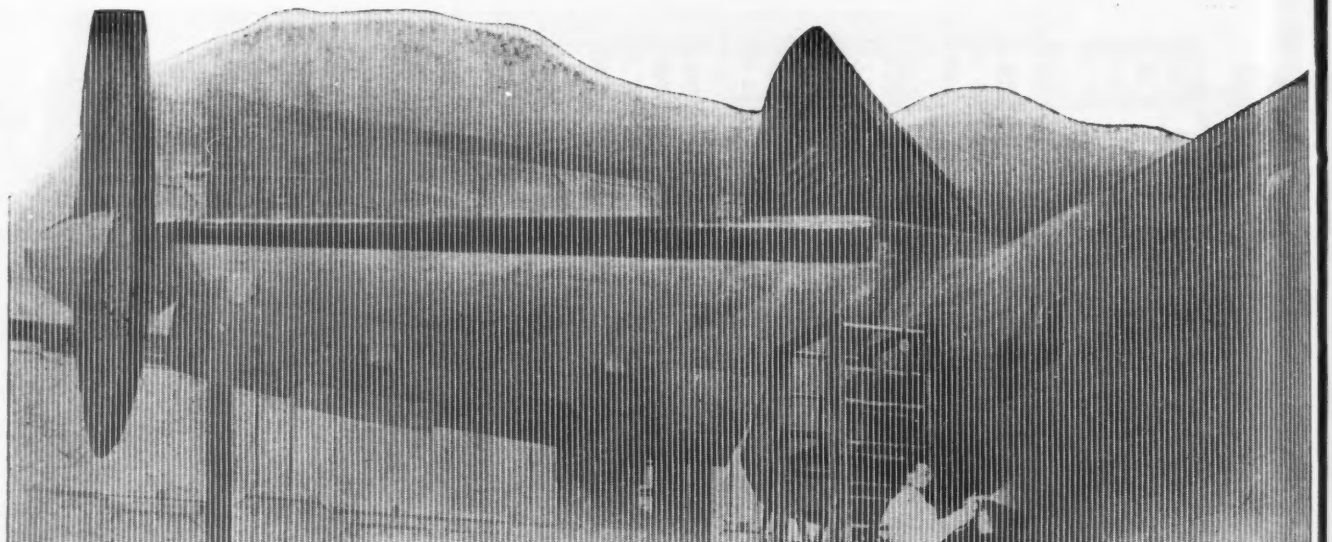

Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing


Two-Lipped Cylindrical Roller Bearing

NORMA-HOFFMANN BEARINGS CORP'N, STAMFORD, CONN., U. S. A. • FOUNDED 1911

TO WIN THE WAR: Work—*Fight*—Buy War Savings Bonds



Out of a Doctor's woodshed came a Startling Air Achievement

● In a woodshed, over 50 years ago, Dr. Allen DeVilbiss was experimenting with air — to apply goose grease in mist form. From this came the invention of an atomizer for semi-solid medicaments.

That was the beginning of DeVilbiss air research. From it has come an amazing range of modern air-operated and air-handling equipment. And ever since Dr. DeVilbiss used air to provide an easier, better method of medication, speed and efficiency have been major features of all DeVilbiss products.

Now, when speed is vital to Victory, it is natural that DeVilbiss serves the Aviation Industry in many ways. For example, one new DeVilbiss automatic sprayer paints small plane parts of different sizes and shapes at the rate of thousands per hour.

And to keep 'em flying, high-speed DeVilbiss Equipment camouflages planes, blacks out hangars, protects engines against corrosion, seals wing and fuselage seams, cleans fuel lines, removes dust and fumes from shop areas, compresses air for service jobs and serves in many other ways.

Are you taking full advantage of DeVilbiss' 55 years of air experience to speed your war work? Are you being air-minded about your shop equipment too? Consult a DeVilbiss engineer about the possibility of speeding up and improving your wartime operations.

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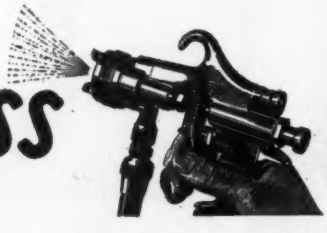
★ ★ ★

PROUD to have won the coveted Army-Navy "E" for excellence in war production, the men and women of DeVilbiss pledge to continue giving their all-out best — for Victory.



DEVILBISS SPRAY SYSTEMS

SPRAY EQUIPMENT • EXHAUST SYSTEMS • AIR COMPRESSORS • HOSE AND CONNECTIONS

floor, then the two top decks, front and rear, are added in side fixtures that move on transverse rails. These move in to mate with the side panels and the floor sections already mounted in the first fixture. When completed this section is lowered onto the bottom panel, which has previously been located in the second mating fixture.

In making up the five outside subassemblies of the forward fuselage, each unit is provided with two heavy cast-steel "T"-shaped straps, located in the primary assembly fixture so that their relationship to the complete unit is extremely accurate. They are bolted through the skin and bulkheads on each unit. The straps are located by removable pins in the assembly fixture, and when the finished part leaves the assembly fixture, they go with it.

When the part reaches the fixture in which the top, bottom and sides are joined together, these straps are used to locate the sections so the mating at the cleavage lines will be accurate and easy to make. When the fuselage section is completed, these straps are all pinned together and completely encompass the finished job. They not only accurately fix the assembly of the component parts but carry on to the semi-final assembly line to assure the accurate mating of the fuselage with the center wing section.

The aft section of the fuselage is similarly handled during subassembly and in mating with the center wing section. The special hoists which lift these fuselage sections off the overhead slat conveyor and lower them into position for mating with the center wing use the straps as a safe means of handling these big units.

To mate the fuselage sections with the center wing section and accurately align the two assemblies at the cleavage line presented a problem that has been solved in a very ingenious manner. The fuselage section is lowered into a carrier car that moves on rails parallel to the axis of the ship. The fuselage is located on this car by the same straps which were used in its subassembly.

Location of the center wing section in relation to the fuselage is the next step. There are eight locating points on the center wing which have to be in line for this purpose. Four temporary locating plates are fastened to the bottom face of each center section spar just outside the fuselage line. These plates have spherical sockets which drop over ball-ended locating pins, which support the center of the wing. Mounted on huge iron pillars, they accurately fix the center wing in relation to the car carrying the fuselage section which is to be attached. These hold the wing in flying position or at about 3 deg. from the horizontal. The outer ends of the center wing rest on two locating points in each of the end towers.

In order to support the center wing section on the locating pins at a mating station the wing must be lowered about six inches. This is done by having elevator sections in the track at each of these mating stations for this purpose. The truck which supports the fuselage is provided with a gear drive to roll the fuselage into mating position. The center wing mating pads have pre-punched rivet holes which are used as guide holes when drilling the mating skin of the fuselage. After the sections are mated, the wing is lifted again to the level of the line.

To prevent the center wing from tipping after the forward fuselage has been attached, a special car running on rails supports the front end until the front landing gear can be attached at a station farther down the assembly line.

The aft section of the fuselage is added in exactly the same manner as the fore section.

Next hydraulic jacks in the end towers raise the whole assembly and the main landing gear is lowered, the nose wheel installed, and the oleos pumped up so the entire assembly is supported on its own wheels. At this point, the center wing conveyor line ends and the floor conveyor chain starts. The trolley conveyor plates are removed from the ends of the center wing and returned to the start of the center wing horizontal conveyor in the center wing department. This is where trolley conveyor plates replace the drill guide plates used on the Ingersoll mill.

Engines, trailing edges, and empennage are installed after the center wing is on its own landing wheels. The engines with their cowling, oil tanks, oil coolers, and intercoolers are a complete unit. They are kept in stock on the overhead gallery and lowered in place by their own special crane at the engine mounting station.

At the end of semi-final assembly, the planes run out onto two transverse slat conveyors in the floor. With the landing gear wheels on, a plane can be transferred to the center of the final assembly line from either primary line.

Platforms throughout the assembly line have folding floors and hand guard rails to allow the plane to be moved past as the assembly advances. The conveyor system in use is intermittent in action, not continuous as in automotive practice.

Planes are moved from station to station by power on the final assembly line. Platforms, most of which are permanent, are constructed at each station to facilitate assembly work.

Elaborate spray booths are located on each of the final assembly lines be-

SPEED-RATCH

REMOVES OR TIGHTENS NUTS *in a Jiffy*

BEALL SPEED-RATCH is the new, improved Ratchet Wrench with patented pull-chain in handle. Quickly and easily tightens or loosens nuts at the hard-to-get-at spots, without finger manipulation. Saves time and speeds airplane assembly and mechanical production. *List price,* $6.00

Manufactured by the makers of
BEALL SPRING WASHERS

WIRE US your requirements
BEALL TOOL COMPANY
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EAST ALTON, ILLINOIS

"Stamps"
FOR ACCOMMODATIONS WITH...

801 ROOMS FROM $4.00 SINGLE

HOME OF THE Hawaiian Room
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Working on the "FORTS"

Krane Kar is used in the production of Flying Fortresses: handling jig sections in erection; handling steel for jig sections; unloading equipment from flat cars; loading aircraft spare parts and assemblies on cars; placing large pieces of production equipment and handling repair parts for same when necessary; lifting, moving, and rearranging production equipment, raw materials, etc.; for building maintenance and repair; etc.

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We are preparing a series of bulletins showing interesting special designs in various types of screws and plastic insets. Around each one there is an interesting story—of designing, production, use, metal-saving, etc. Our mailing list is not complete, hence this advertisement seeking out those who might be interested in receiving these bulletins—are you?

We make all types of screws — machine, metal, plastic insets, machine screw nuts, special rivets, etc. Every one — Keene quality.

SEND FOR

NEW ENGLAND SCREW CO.
KEENE, NEW HAMPSHIRE
INCORPORATED 1892

SCREW BULLETINS

yond the turntables. Water sprays are used to catch the "over-spray". This is handled by down-draft ventilation through gratings in the floor.

After painting, the bombers enter the pre-flight area of five stations. Here propellers are added, seats, radios, and instruments installed. Fuel is added at the last station in the special fireproof room, at the end of the assembly line.

Here, the flight department takes over the craft and wheels it onto the flying field apron. This department has a huge service hangar in which operations can be carried on regardless of the weather. When accepted by the Army Air Forces, the *Liberators* are turned over to the Ferry Command for fly-away delivery from Willow Run Airport, which is an integral part of this tremendous project.

Those Claims Are Right

(*Continued from page* 118)

with the *Mustang* and the *Spitfire* as basic designs whose structures will be adapted to the installation of the *Merlin* 61 using 110-octane gas.

Blue Print for Peace

Allied air responsibilities in a global war rate military requirements first, but now that the United States and Britain are thinking over and jointly discussing postwar peace problems the subject of air transportation has become headline news in both countries. Respective politicians urge that peace must have an international flavor if it is to be successfully maintained, and there seems good reason to believe the majority of thinking folk in both countries agree that continued close cooperation of the U. S. and Britain is not only desirable but is essential in peace as in war.

Efficient transportation will prove one of the mainstays of peace, while both the conception of a free new world and the speed with which conditions of living normality can be restored in the devastated Axis-ridden countries, and also among the victorious Allied nations, will rely on a network of transportation operating on a united basis.

Because long-range transportation has become the accepted method of meeting urgent war needs on account of its speed, so will it become the foundation of a successful peace if handled with the same open-mindedness with which Allied war problems are met.

The recent speeches of Mrs. Luce and other Congressmen were headlined here in the newspapers so that many Englishmen got a vision of a U. S. avaricious for power and control of the commercial air. Apprehensions were strengthened by the British government's seizure of Short Brothers, Ltd., which has built so many successful flying boats for the British Overseas Airways Corp. Moreover, the creation of the RAF Transport Command, which immediately absorbed BOAC into its sphere of operation, caused a rift among the corporation's directors, most of whom resigned. The fact that up to this writing no new directors have been appointed, together with the British government's inadequate suggestions for filling the vacancies, has caused English concern over the position Britain will occupy in postwar planning of air transportation.

This concern has been increased by misleading newspaper statements implying that the U. S. will have a passenger and freight plane monopoly after the war because Britain is not producing in this category. Like Britain, the U. S. will not be able to shut down her airplane production lines immediately the war is over, therefore American commercial planes will be at once available for British purchase until a percentage of English warplane plants can be switched to commercial requirements.

With the great American resources already producing these large transport planes, might it not be both uneconomical and detrimental to the Allied cause if Great Britain attempted to convert some of her present plants to transport plane production? Careful consideration is necessary here.

There seems no reason why Britain and the U. S. should not step off together on the same foot and keep in step on air transportation problems. Now that discussions on postwar planning are started and viewpoints are being aired, politicians and statesmen of both countries must consider with realism air transportation's important contribution, and they must consider the formulation of a practical blueprint for peacetime international air transport.

It is felt here that this coordinated agreement is necessary now.

Northwest Deliveries

(*Continued from page* 227)

no experience in the big woods. Above all, a respect for arctic weather is stressed, as something with which no chances are to be taken. All this material is closely examined and revised in the light of reports by men who have had occasion to put it to the test, as in the case of the previously mentioned pilot who could not find what he wanted. It was not enough to have everything aboard the plane when considerable searching was necessary to

ABSOLUTE BALANCE
Probably no other part of the airplane motor is made with more care than these motor master connecting rods.
All surface must be ground or polished to reveal any flaws which might be present—to remove any surface defects where stress cracks might start. The bearing parts must be ground to extremely high standards of accuracy—and when finished the whole rod must be in absolute balance.
For all of these grinding and polishing jobs the aviation industry depends on Norton abrasives—grinding wheels, mounted points, abrasive grain, abrasive paper and cloth.
NORTON COMPANY
Worcester, Massachusetts
NORTON ABRASIVES

The Man at the Lathe Fights Too!

... and every turn of the spindle, as he guides his work through many precision operations, helps bring Victory one step closer.

Hours spent at a lathe may lack the dangerous excitement of combat—but the valorous men on the battle fronts breathe a prayer of thankfulness for guns, shells, planes, tanks—for all the superb equipment which is helping them swing the tide against the Axis.

So the man at the lathe is a soldier, too, as he bends his shoulders to the task of pouring out weapons in an ever-increasing stream. He faces his task grimly... proudly... proclaiming by the gleam in his eye and the jut of his jaw that he will not be outdone in service to his country, and knowing that America's production is a decisive factor in the war.

To help America "tool up for Victory," the output of South Bend Lathes has been increased (we can't say how much) in the last year and a half—giving the man at the lathe the efficient, dependable production weapon he must have to win.

There is a South Bend Lathe for every class of work—engine lathes, toolroom lathes, and turret lathes. Write now for our new catalog No. 100B in which the entire line is illustrated and described.

SOUTH BEND LATHE WORKS

LATHE BUILDERS FOR 36 YEARS

SOUTH BEND, INDIANA

reach the right articles. Since then, every effort has been made to carry all items in standard placement for each type of airplane.

The whole subject is closely parallel to operation over the sea, except in equipment. Units must be made self-sufficient, in order to subsist until found and rescued. Services performed in this respect have been heroic, with excellent cooperation between the U. S. Army and Canadians in locating mishaps and rendering assistance. Occasionally missionaries with dog teams have come to the aid of grounded men, and in certain places dog teams are kept in readiness to help in case of accident.

There is one tale of a P-39 forced down by engine trouble on a lake covered with snow. The temperature was 55 below zero, but the plane was quickly located by radio and a Noorduyn *Norseman*, or UC-64, was dispatched to the rescue. Supplies and men were flown in to get the plane out, a hoist rigged to change the engine, and a replacement installed. It took 16 men 21 days to clear a runway in the snow 2,000 ft. long and 50 ft. wide, but they did it, and the airplane was flown out.

Another single-engine craft was forced down in snow on a lake and broke the landing gear in the process. The nearest road was impassable, and spring thaw was approaching, which cut time short to save the plane. Spare parts were again flown in by a *Norseman*, which is an indispensable airplane for this type of work. Space available for take-off was scant, but the fighter's engine was opened up with brakes on, and released for a "jump" start. A recording accelerometer in the *Norseman* following closely behind registered seven G, and the fighter was far ahead of that.

A rather freak mishap is recorded of a P-39 whose engine went dead. The pilot dove down to land on the nearest lake he could find, but came in so fast he overshot, pulled up and around in a tight turn, only to overshoot a second time! The plane was cracked up, but the pilot saved. He had the presence of mind to get on the radio the instant his engine quit, so that a rescue party was in the air almost as soon as he landed.

At the time the Road (as the Alaska Highway is simply named by its builders) was started a year ago March, the Ferrying Group operated the whole Alaska route. The Alaska Wing of the ATC was organized last November. Most recent organization is the Air Service Command, which actually serves as a "housekeeping unit," runs the bases, and handles cargo and supplies for operating units. The ATC takes care of maintenance and operation of the airplanes and routes, and is comprised of commercial subcontractors—United, Western, and Northwest—who have made valuable contributions in planes and personnel trained for the job. Civilians in the group are responsible only for airplane crews and maintenance of the craft.

The Department of Transport of Canada has installed all the radio communications, and enlarged fields and runways all up the line. But selection and initial work on all of these was done by commercial airlines which had explored this region, notably Yukon Southern, which is now part of Canadian Pacific. One man in his sixties, a Mr. Craig, working for Canadian Pacific, put in a level dirt runway 60 yd. wide and 3,800 yd. long at Ft. Nelson with four horses and a couple of helpers. The present field has been paved and enlarged on the same site.

Before the highway was completed, much heavy equipment had to be flown up in DC-3's, including tractors, gasoline (at $2.50 per gal. delivery price), food, and three saws mills for installation where lumber could not be hauled or flown and therefore had to be made on the spot. Watson Lake was one of these places, and there are now several fine wood buildings built entirely of timber milled there.

In the early days of the Road, there was a lot of tough work and many adventures. In winter, truck engines were kept running 24 hr. a day because of the intense cold, for if they ever stopped, they never started again. In one place a truck dropped through the ice, and a frame was built around the spot to provide a base for lifting it out. Grappling irons let down through 30 ft. of water hooked fast to the chassis, and the truck was salvaged. Many an airplane has been saved in the same way, and the tasks accomplished in the face of all probability are little short of incredible.

In all operations of both the ATC and the Ferry Group great credit is given to factory service representatives of the aircraft and auxiliary equipment manufacturers. They have served as indispensable aid not only in keeping their equipment running, but also to train and instruct new Army men sent into this region. They have been used additionally to assist in pilot briefing, giving pointers on care and use of machines in cold weather in the open. New pilots are often annoyed at having to jump out of an airplane at the head of the runway just before take-off to remove a cardboard cover placed over the oil cooler—they would rather do this at the hangar before taxiing out. But the result of this is that the oil so congeals in the cooler that during take-off, when it becomes necessary to cut in the cooler, the pressure bursts the restricted tubes.

The excellence of instruction and

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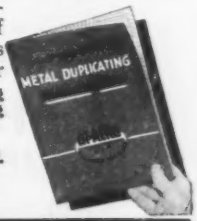
No delay waiting for dies — parts ready quicker — deliveries speeded up — all to bring the Victory sooner! Women are rapidly taking a major place on the industrial front. DI-ACRO Precision Machines — Shears, Brakes, Benders — are ideally suited for use by women in making duplicated parts accurate to .001"—DIELESS DUPLICATING. Thousands of DI-ACRO Machines are now in use in War plants. **Write for catalog —"Metal Duplicating Without Dies."**



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BALL BEARING **GRINDERS**

BALDOR Pedestal Grinder No. 121; 2 HP ball-bearing motor, 1725 rpm; complete with 12" x 2¼" wheels and starter $205.60

BALDOR ELECTRIC COMPANY
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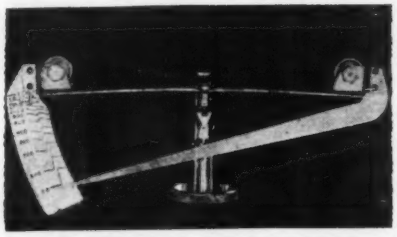

For a Quick, Accurate Check on

CABLE TENSION

This Aircraft Tensiometer fills the need for a light, compact and dependable instrument for aircraft use. It weighs but eleven ounces, and is so compact that closely bunched cables offer no difficulties. For an accurate reading simply pass cable over rollers at ends of instrument, slip under hook at center and turn the knurled nut until lightly clamped. Pointer on quadrant registers immediately. Two scales are provided—one for 5/32" stainless steel control cable, the other for standard #10-32 streamline wire.

For complete data and price write for Catalog #155.

GEOPHYSICAL INSTRUMENT COMPANY
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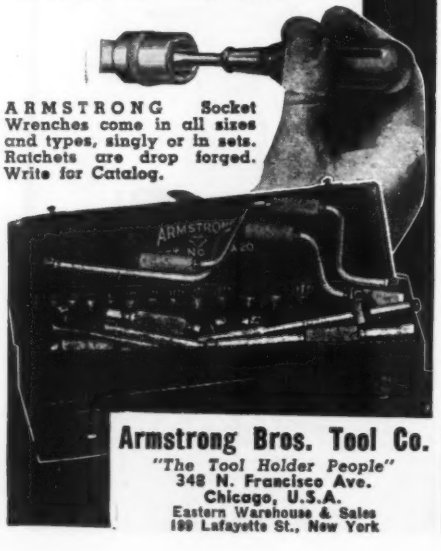
The Socket Wrench with the DRIVELOCK

Have you tested the ARMSTRONG Vanadium Super Quality Socket Wrenches featuring the patented ARMSTRONG DRIVELOCK? This exclusive Armstrong feature locks socket to driver, driver to extension, extension to handle—heads positively will not knock off. These are the only safe wrenches to use around moving machinery. Parts are quickly and easily detachable.



ARMSTRONG Socket Wrenches come in all sizes and types, singly or in sets. Ratchets are drop forged. Write for Catalog.

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preparation for operations through to Alaska make it evident that the Army is doing a thorough job to insure least possible losses in a very difficult task. The bitter opposition of winter weather in the northwest brings hazard and hard work to nearly every move, and can be fully appreciated only by those who have experienced it. Any pilot sent through this district has been given the best of knowledge to serve him, and if he fails to use it the burden is on him. There are route manuals in preparation, and excellent material on arctic climates has been put out by the Airlines War Training Institute. The Wing agrees that after all that has been learned this last winter there is no fear for the next one.

How efficient ferrying through can be is illustrated by a pilot who made a delivery from the U. S. to Fairbanks, and was back in the U. S. eating dinner inside of 30 hr.—and it's nearly 2,000 mi. each way.

Slump . . . . Or Surge?

(*Continued from page* 113)

More alluring is the prospect of the company entering the automobile manufacturing field. This possibility on the part of the aircraft industry has long been discussed and may find substance in actual developments. Significant were the comments of Lockheed's Pres. Gross at the time of acquisition: "We must look forward to the day when our industry will have new responsibilities to the nation's society and economy."

If the aircraft industry is to diversify, there is no limit to the number of products it can manufacture. It need not stop with the automobile. There are various types of household goods and electrical appliances, also a host of other types of durable goods and equipment that can be produced from aircraft manufacturing facilities. The latest manufacturing techniques, new metals, and materials all have widespread adaptations to a host of products.

The markets anticipated in these fields are indeed staggering. Again using the Department of Commerce survey, the projected 1946 markets in the fields which the aircraft group may likely tread, are presented in our accompanying Table I. The marketing opportunities indicated in passenger cars alone are highly inviting. A market placed at $5,718,000,000 is enough to cause any aircraft builder to give serious consideration to entering the field.

Established companies in their respective fields will, of course, present a formidable competitive obstacle, but if the markets are to be as extensive as indicated, the difficulties facing the approach of the aircraft builders will be more apparent than real.

Yet in the face of this hopeful outlook and revival of considerable "romance" in the aircraft group, leading equities of the industry have been experiencing a sorry time in the investment markets. This has long been noticeable in watching the stock averages appearing in this space (Table II). For example, last year the Barron's aircraft average was about 60 percent higher than that of the air transport group. Currently, however, the air transport average is selling at 10 percent higher than the aircrafts.

More noticeable is the long downward trend that has pursued leading aircraft shares for five years or more (see Table III). The annual highs since 1938 and current prices are presented. Despite the advance in the general market, the aircrafts have refused to participate and have been successively lower throughout the years. This characteristic, also common with steel, copper, and other equities in the "war baby" categories, not only shows what disfavor issues with a war flavor have attained but is also a reflection of the uncertainties to be faced in the postwar period. However, as the unknowns of the aircraft group become clarified and as positive and tangible developments unfold (with consideration of existing

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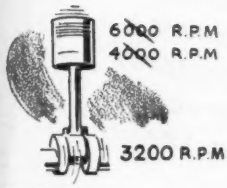
WHEN *Auxiliary Power* MEANS SO MUCH

RADIO LOG

First day down — Plane badly wrecked. Communications with base hot and heavy - thanks to the auxiliary power unit working smoothly charging batteries.



• LOW SPEED

• LIGHT WEIGHT

• COMPACT SIZE

● Main engines dead . . . normal power supply out of operation . . . yet crew members of a crashed bomber equipped with an Andover Auxiliary Power Plant can maintain contact with their base.

The Andover Auxiliary Motor is also a dependable source of electric power for lighting, heating and the operation of galley hot plates until rescue parties arrive. This compact, light-weight motor is not only proving its value in normal operations—main engine starting, interplane communication, bomb hoists, turret operation, etc.—but also in emergencies where the safety and comfort of the crew is involved.

Its conventional design conforms with accepted aircraft practice—a design that will play an important part in the peace-world of tomorrow as it is doing in today's warfare.

The Andover Auxiliary Motor is a 2-cylinder air-cooled engine driving a 28-volt generator supplying a continuous power output of 5 K.W. with a peak load of 7½ K.W. Its weight complete, with all accessories, including generator and regulator box, is only 125 pounds.

ANDOVER MOTORS CORPORATION • ELMIRA, N. Y.

WHOLLY-OWNED SUBSIDIARY OF ANDOVER KENT AVIATION CORPORATION

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Quick action on attack brings many glorious victories to our gallant navy. And quick action on the production front in supplying needed equipment spurs the confidence of our boys for those further victories that will drive the enemy from sea, land and air.

Action here at Acme means we are breaking all previous records in producing tools, tool engineering, patterns and heat-treated aluminum castings, to help war production plants deliver essential equipment on time.

Our service is complete -- including engineering service of long experience. Don't hesitate to call on Acme to keep your bottlenecks down -- to step your production up.

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Heat-Treated Aluminum Castings—Patterns—Tools—Tool Designing—Production Processing

For VICTORY buy WAR BONDS and STAMPS

price levels), it is probable that aircraft shares may once again enjoy added luster in the market place.

Substantial growth in air transportation has long been anticipated for the postwar era. It is probable that the airlines will attain an increasing share of the transportation market. The Department of Commerce study placed 1940 expenditures for all forms of transportation at $2,152,000,000, and the projection for 1946 is $4,159,000,000, an "up" of 77 percent. It is difficult to say what proportion of this will accrue to the airlines. For 1940, the domestic industry had revenues of about $80,000,000 from all sources. On this premise, if 10 percent of the projected total transportation market of 1946 would be served by the airlines, $415,900,000 would be involved—more than five times the volume of business handled during 1940. No small undertaking!

The National Resources Planning Board estimated, in one of its recent reports, that within the next decade or two air travel in the United States will assume approximately 70 percent of present-day Pullman rail travel or approximately 6,000,000,000 revenue passenger miles—equivalent to transportation of about 20,000,000 passengers a year. In its 1942 annual report, the Civil Aeronautics Board expected this figure to be reached by 1946. Further, the projection was advanced that in the same year transocean and international air passenger traffic under the American flag alone will increase six times and mail and express at least eight times over that carried during the year ended Apr. 30, 1942.

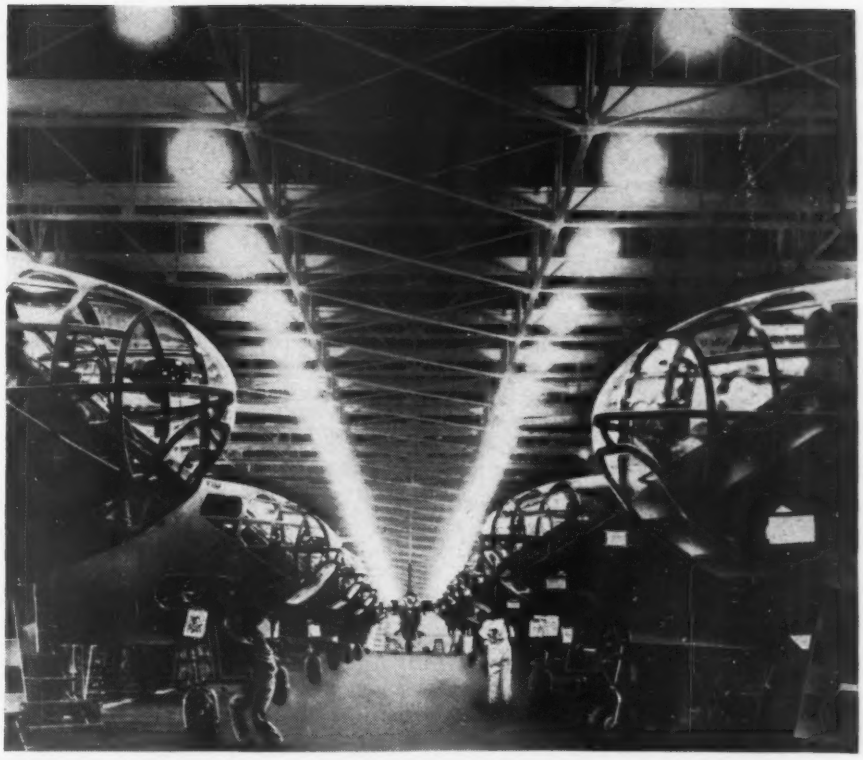
The growth factor in air transportation is indeed stimulating to the imagination. However, along with this expansion will come new problems and new obstacles as inroads are made on other forms of transportation and as competition within the industry, unless restrained by the regulatory processes, becomes more intense.

The search and battle for wider and greater markets in any industry never was of the scope to involve an inexpensive campaign. Accordingly, air transportation's quest for broader plateaus does not promise to be a cheap affair.

Letter to Berlin

(*Continued from vage* 112)

to estimate the man-hours of labor required. The sum is colossal in itself, but remember that while this expansion continues it may be necessary for some manufacturers to recruit enough additional workers to replace one-quarter or one-third of those already on the job to meet the demands of Selective Service. It is hoped that we will not find



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In time of war prepare for peace! Now that Victory is possibly "just around the corner" prepare for increased production of planes for civilian use by learning about MAC DERMID'S new, positive compounds for cleaning basis metals, developed for all out war production.

USE METEX AERO CLEANERS for complete removal of oils and greases prior to anodizing parts of aircraft engines and METEX #8 for removal of wax coatings and alloy marking inks from sheet and shaped aluminum. . . . Other METEX COMPOUNDS especially formulated for other specific problems.

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Read how these accepted and approved compounds can speed up and improve your pre-finishing-plating operations and improve the luster of your products . . . . Separate data sheets on specific problems available on request.

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ourselves in the position of those other countries which have been forced to the inefficient practice of training men for military service and later withdrawing them from their armies to fill a greater need on the production lines. Mismanagement of transportation facilities and food resources may also create conditions having a bearish effect on the over-all production effort.

At this stage it is folly to predict the time of victory. Even the tactical lessons learned in the Tunisian "laboratory" are not sufficient to enable us to foresee what lies ahead when we succeed in contacting the main strength of the enemy. But with due consideration of these and other factors there is one point of which we are certain, and upon which we can base our predictions of the future course of production—our production ratio of more than 3 to 1.

If we base our speculation on this ratio, and our estimates of the production of other nations are most realistic, we cannot escape the thought that the flattening period for U. S. production is not far off. From the standpoint of present availability of capacity for production of materials and components, a convenient flattening point would be in the neighborhood of 10,000 planes per month. That would provide a total annual production of about 120,000 planes in 1944. It would bring the U. S. cumulative production total for the five-year period ending at the close of 1944 to approximately 285,000.

We have undergone some losses and will suffer more. But so far the box score of enemy planes shot down compared with our losses has been greatly in our favor. It has varied from an average of about 4 to 1 to an amazing high of more than 20 to 1 during one three-day period of Mediterranean operations. In attempting to evaluate our advantage over our opponents we must add this quality factor to the quantity factor of our increased production. Even if our average loss ratio dropped as low as 2 to 1, the net result in effectiveness would be the same as doubling our actual production.

The confidence in early victory expressed by these production charts must not lull us into the false belief that the war has been won. Actually, this splendid production achievement is only one part of the story. We must not only forge the tools of war but we must transport them to the front and use them to the best advantage. Even when all this is done there are many unknowns in the war equation, on the home front as well as in the field. Unusual weather conditions, famine, floods, and other acts attributed to God by men who failed to use their foresight to prevent them, play a predominant part in warfare.

Review of Books

(*Continued from page* 305)

appears no evidence that the Board considers it expedient for the ratio (of traffic and advertising expenses to passenger revenues) to be the same for each carrier. CAB's thinking is not uniform on who should and should not spend more per revenue-mile for promotion.

"The regulation of the airlines will be sucessful in so far as the CAB lays down general rules which are to be followed by the carriers. The danger in the situation arises when the Board begins to assume the functions of management as evidenced by this action on promotional and advertising expenditures."

Split-Second Recognition

(*Continued from page* 119)

What the Renshaw system is and what it does can best be described by showing what goes on in an Army school where Air Forces, Infantry and Coast Artillery personnel are trained as Renshaw instructors.

Conducting the school are three young lieutenants who have been graduated by the AAF School of Applied Tactics at Orlando, Fla. They are not only thoroughly informed on the prac-

TO THE ATTACK IN PIONEER PARACHUTES
These are Paratroopers without parallel — hell-divers, jumping jacks, loop-the-loopers! Versatile, tough and deadly, they're infantry and commandos all in one. These Allied paratroopers are the stalwarts who swoop to earth ahead of battle and fight it out until G.H.Q. receives the report "objective taken." Pioneer fool-proof and foul-proof parachutes are playing a big part in the offensive sweeps of these "sky-terriers". Pioneer parachutes are not only an instrument of safety — they're an instrument of offense!
PIONEER PARACHUTE COMPANY, INC.
MANCHESTER, CONNECTICUT, U. S. A.
CABLE ADDRESS: PIPAR.
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tical techniques which they pass on to the students, but have an intimate knowledge of the psychological background on which the system is based.

In evaluating the system it must always be remembered that it is primarily a course in eye-training—for increasing the visual acuity of the men learning it. They must be taught not only to see more, but to see it better.

The eye-training is given by flashing series of digits on a screen. A five-digit series will be shown for 1/50-sec., six digits for 1/25-sec., and seven digits for 1/5-sec. By the time this phase of the training is completed the students are able to read six digits in 1/100-sec., seven in 1/50, and eight digits in 1/10-sec.

What has happened is this: the men have broadened their field of vision by intensive practice. Whereas their eyes might be compared to a rifle at the outset, hitting a comparatively small target, they are able to function in the much larger pattern of a shotgun after training. Or, to use a photographic analogy, the normal lens has become a wide-angle lens.

In the instant of time ranging from 1/5 to 1/100 of a second it is impossible to scan or read the digits from left to right as one would do normally; the entire series must be seen as a unit. The eye-training starts with the beginning of the course and at the same time the men are learning by identification and concentrated study the characteristics and potentialities of the planes, ships and land vehicles they will finally be able to recognize at a glance.

The school assumes at the outset that the students don't know a *Fortress* from a *Spitfire,* a Mark VI tank from a jeep, or a battle cruiser from a dinghy. Every model of the flying, floating and rolling stock they must know is introduced systematically, but rapidly. First, students are familiarized with recognizable features—type of wing, fuselage, tail assembly, number of engines, etc. When these details are mastered the process of recognition is superimposed on the already accomplished identification.

Pictures of the planes are flashed on the screen for 1/25 sec. The planes are more easily recognized than the digits because they have character, but at a "Ready . . . now" warning the classroom takes on an atmosphere of hushed concentration. Every future instructor leans forward in his chair as if to draw the fleeting image into his eyes—their bodily exertion reminds one of a pinball machine player's "body English" or the driver of a reluctant car trying to "lift" it up a hill from behind the wheel.

Following the fleeting flash on the screen, students write the name or model of the plane. After a few seconds the instructor, or student operating the machine, gives the correct answer. This occasionally brings forth an oath from one of the students, and it always means one thing. The man had the correct plane written on his answer sheet and changed it. In this type of recognition work first impressions are almost invariably right—if the student has to think about it he doesn't really recognize the object shown and will almost always guess wrong.

But when the course is completed, the men really know. Repeated tests have shown that even with the photographs put badly out of focus—even upside down—the Renshaw graduate is sure of the craft shown. So improved have teaching techniques become that classes now learn more than 65 friendly and enemy aircraft, over 35 classes of surface vessels, and some 50 types of armored land vehicles.

Instruction embracing these many types is excellent from the standpoint of maintaining interest. The students are not only competing against perfection but against each other, and many a man who felt himself imposed upon when he was assigned to Recognition School is soon betting on his ability to recognize more planes in a hundredth of a sec. than his neighbor. Members of the class also enjoy operating the projector and conducting the recognition sessions, but woe betide the "teacher," be he corporal or captain, who errs in naming a plane after flashing it on the screen. He'll be promptly and emphatically corrected—with gestures.

Men taking the course find that it gives them an advantage over veteran pilots, on whose ability to recognize fast moving objects the wholeness of their skin depends. Recently a pilot from the South Pacific theater of operations visited the school and admired a photograph of a *"Spitfire."* "A what?" asked one of the instructors. "That's an *Airacobra.*" The visitor's reply was sheepish but frank. "My God, but I'm dumb. I've been flying one of those things for the last three months."

Similarly, tanks and other ground vehicles are presented, as are ships. In the case of ground and sea forces it is particularly necessary that an observer be able to tell at a glance the number of units involved as well as the type.

Ranking U. S. officers are anxious that no Yank make a mistake like the one that led to the greatest Italian naval victory of this war. One day a flight of Il Duce's bombers sighted a task force in the Mediterranean and bombed it so skilfully that three cruisers and four destroyers were sent to the bottom. The triumphant flyers landed, their chests arched to receive the well-earned decorations, and were thrown into the guardhouse. The ships were Italian.

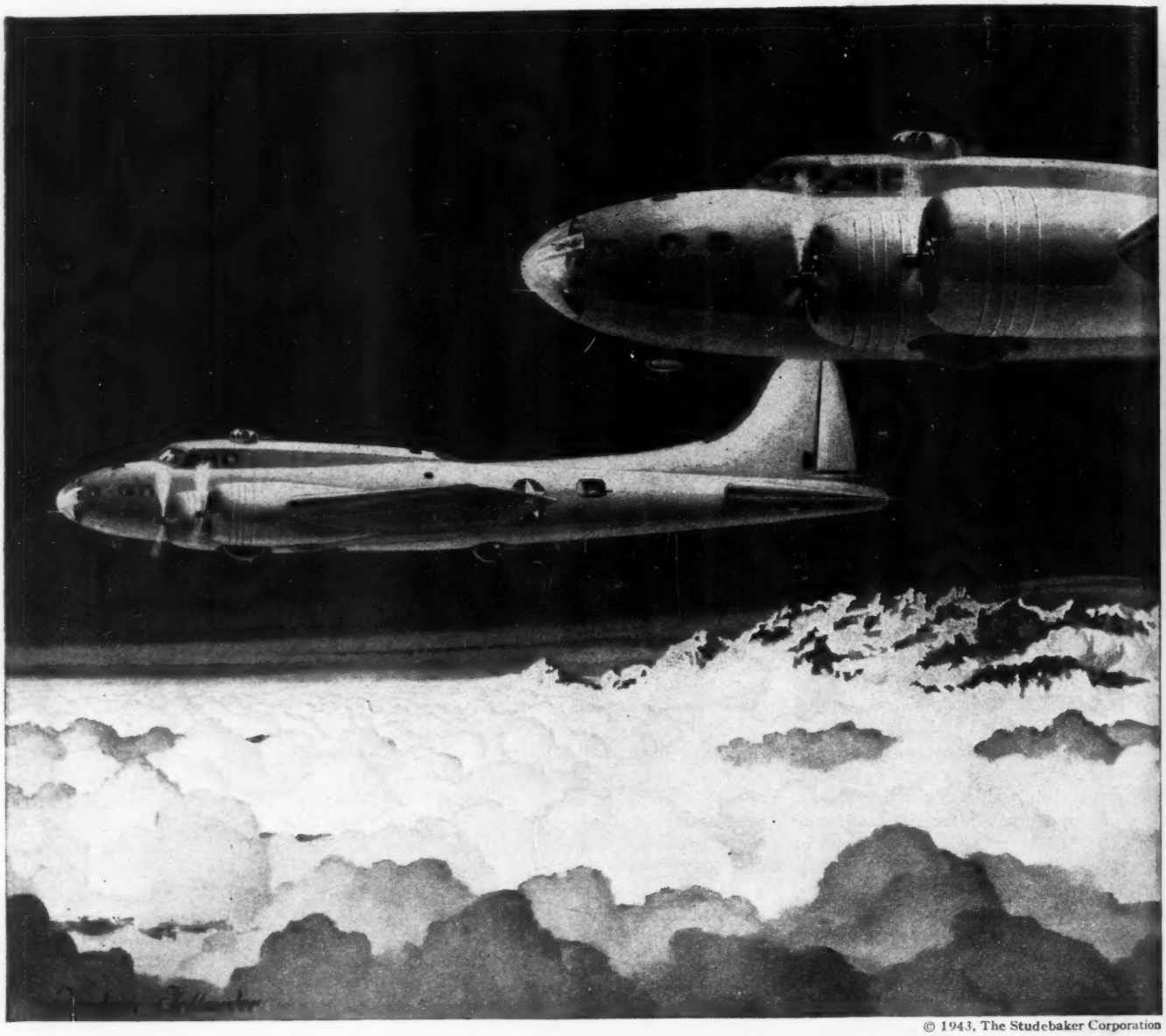
On another occasion units of the astigmatic Italian air force reported a British force of three light cruisers in the same sea. The Fascist admirals dispatched a group of destroyers and light cruisers to intercept the enemy, but the Britishers, which were heavy cruisers, blew Musso's ships out of the water before they got within firing range.

Throughout the entire course the men are taught in detailed technical sessions the construction, armor, armament and other characteristics of land, sea and air craft, both of United Nations and Axis origin. Thus a Renshaw graduate knows the strength and firepower of any enemy force he may encounter; knows whether it can be attacked with a fair degree of safety and how, and from its type of equipment its probable mission.

The students are by no means judged simply on their ability to absorb the material given them and the skill which they achieve. They are being trained to become teachers and on them depends the success of the program as far as field courses are concerned. Every man gets several opportunities to conduct the class, present technical discussions and operate the equipment. If he does not show qualities of leadership and the ability to impart what he knows he will not be graduated as a teacher. He will be given credit as a graduate observer. Officers conducting the school report that the man who knew less than he could teach was considered a much more satisfactory educational product that the student who knew the course like the palm of his hand but showed small ability to transmit it to others.

The equipment used in the course, which runs 36 hr. per wk. for four wk., is neither complicated nor unwieldy for field use. The pictures are shown by a small projector of common type, equipped with a Wollensak Alphax f3.5 lens, with speeds up to 1/100 sec. Almost a thousand slides fit in a case the size of a fairly large suitcase, and the 3x5-ft. screen is, of course, rolled. These, with pictures, charts and answer forms, make up the kit of the instructor who returns to his base to teach the Renshaw System in a course of approximately 36 hr.

In addition to this specialized training the students get a "liberal education" in aviation. Daily there is an hourly talk by such varied representatives of the flying world as fighter pilots, commercial pilots, manufacturers, writers and editors of aviation material (including several of the staff members of this magazine), navigators and test pilots.



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More and more Flying Fortresses are powered by Studebaker-built Cyclone engines

Clear-eyed, clean-hearted young Americans are up there in those Flying Fortresses—writing new chapters of a free world's destiny. Many of them were carefree school boys only yesterday. Today, they're pouring cringing fear into the souls of once boastful "supermen." To these gallant youngsters—and to their expert crews below that keep them flying—we of Studebaker pledge ourselves to go on producing more and still more of the mighty Wright Cyclone engines for these devastating Boeing bombers. We recognize and respect the responsibility for maintaining quality that the Army-Navy "E" Award has placed upon the Studebaker Aviation Division plants. We'll "give more than we promise" in the best Studebaker tradition. Meanwhile, civilian needs must and will wait . . . until Studebaker completes this wartime assignment . . . until the finer Studebaker cars and trucks of a brighter day can be built.

Big Studebaker military trucks stand out in all the major war zones—Besides producing many Flying Fortress engines, Studebaker is also one of the largest builders of multiple-drive military trucks. We're proud of our assignments in arming our Nation and its Allies.

★ BUY U. S. WAR BONDS ★

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Studebaker BUILDS WRIGHT CYCLONE ENGINES FOR THE BOEING Flying Fortress